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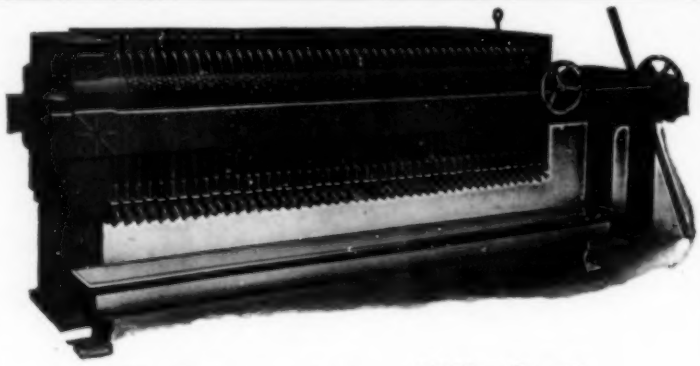

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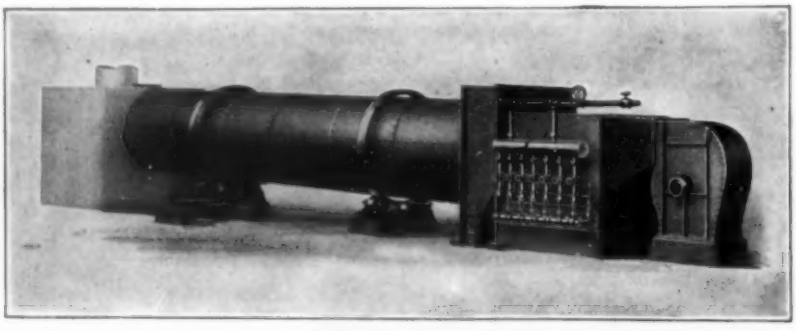

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A Charming Human Document

At the last New York City meeting of the American Institute of Mining Engineers in one of the iron and steel sessions the feature overshadowing completely in human interest the balance of the proceedings was a contribution to the discussion of one of the papers. It was made by Mr. Alexander E. Outerbridge of William Sellers & Co. of Philadelphia on experiments carried out by him many years ago on the growth of certain iron castings. Mr. Outerbridge spoke at length and really upset the schedule of the whole meeting, but he fascinated his audience and received an ovation. What was an old story to him was all news to his hearers. We fancy that Mr. Outerbridge's paper on "Metallurgical Processes in the Foundry," published elsewhere in this issue, must have had a similar enthusiastic reception when presented before the Philadelphia Foundrymen's Association. There is an incomparable delight in hearing a nestor of an industry speaking modestly of his work of a lifetime. And Mr. Outerbridge's paper is a charming human document. The American foundry industry may be well proud of its achievements and of the American metallurgists like Outerbridge who produced them. And then it is always pleasant to be reminded again and again how many real good things have come to us from quiet, unassuming, industrious Philadelphia. Two-score years of metallurgical life in Philadelphia are recorded in the paper.

Steel for War

When we entered the war there were predictions that the Government would require 5 or possibly 10 per cent of the steel output. The president of one of the steel companies, who seemed to employ an unnecessarily large factor of safety, asserted that the requirements would not amount to 20 per cent. Now there are estimates running as high as 40 or 50 per cent.

A bewildering mass of requirements in steel has accumulated already and perhaps the end is not yet. In the case of most of the groups of requirements there is not even a tentative estimate of the tonnage of steel involved, particularly in terms of the rate of output. For instance, to build ships of 3,000,000 gross tonnage there has been a rough estimate that 1,000,000 tons of plates and 300,000 tons of structural shapes will be required, but the 18 months' time in which the ships are to be built is purely a guess, and therefore the proportion of the steel output involved in 1,300,000 tons is not known. It would be between 2½ and 3 per cent if the deliveries were spread equally over a period of 18 months.

The steel required in building sixteen cantonments,

cities for 40,000 inhabitants each, might be thought to run into large tonnages, but it seems the total will be only a few tens of thousands of tons, and when the work is completed, in a very few months, there will perhaps be no more required in that quarter. In other construction work, such as of hangars, shipyards, etc., the tonnage of steel will be much larger. A report that circulated some time ago, referring to 200,000 tons of steel for hangars, received little credence, but in the light of later information the estimate does not seem unreasonable.

In the case of much of the war activity there is a replacement in form rather than in substance. Thus the Government will probably order a large number of freight cars and locomotives, which in normal times would be bought by the railroads direct. The railroads have not been heavy buyers, partly on account of prices asked and partly because the car and locomotive shops could not secure full supplies of steel. The Government can take a hand and control both prices and deliveries. The car shops, which for months have been working at only about half capacity may eventually be working at nearly full capacity.

As to the shell requirements of the Government, the only important steel buying thus far has been 81,000 tons for 9,000,000 3-in. shrapnel and high-explosive shells. Much larger tonnages will, of course, follow.

In 1916 the steel exported directly to the Entente Allies or consumed in manufacturing wares for them amounted to between 15 and 20 per cent of our total steel output. The remaining exports, perhaps 5 per cent, went to neutrals. Exports to neutrals are, of course, practically shut off. If our Government buys more largely for the Allies than they did last year their proportion may be 20 or 25 per cent, and if ours were the same the total would be 40 or 50 per cent. The remainder, for ordinary consumption in the United States, would be 50 or 60 per cent, against 75 or 80 per cent last year, no great change after all, particularly considering that the percentages now refer to a somewhat larger steel making capacity. In view of the facts that commercial building on a large scale is likely to dwindle to insignificant proportions, and that much shop capacity to work steel into finished forms will be diverted from private to Government work there is no safe ground for assuming that steel will continue to be as scarce as it is now.

The Art-Science Divorce Scandal

In the cheerful days when Rembrandt van Rijn arranged, had, and from a reasonable distance enjoyed his own funeral and then watched the prices of his pictures soar; when Frans Hals would sober up now and then and dash off an immortal canvas with thirst driving him to short-cuts that to this day painters strive after at hard labor; when Jan Steen would not listen to the voice of propriety but chortled with unholy glee whenever a drunken row began—and painted it, artists "went in" for science. They kept linseed oil for fifty years and more and were very careful to select and grind and mix their own colors. They clung to renaissance traditions, but the traditions were sound—as witness their canvasses to this day. Later painters experimented without the vision of the research mind, and their canvasses show their frequent errors. It is not always wise for the uninformed to try experiments. Then followed the trade of color making as a thing apart from painting, and the painters lost interest in it. Chemistry has come into the paintmakers' trade, but artists, as a rule, do not know or care about it. They buy by label and discuss the qualities of Permanent Green, for instance, without knowing what it is made of.

Science is not welcomed into art any more. Somebody always fears that it is too material and that the artist's gift of the vision of beauty will fade away if he but knows the substance of the materials he uses. Of course, if his artistic sense is so frail that it will wither in the face of needful knowledge, it goes without saying that it is not robust enough to make a real artist of him. In a very distinguished company, not long ago, the deterioration of the work of a well known artist was considered during an informal discussion on landscape painting. A modest member of the company ventured the suggestion that the particular painter's geology was defective; that his later imaginative work was based on a series of geologic sequences that went backward. He was immediately taken to task for demanding that any painter should engage in a study so disturbing to his work and so contrary to the spirit of his task. The others were unanimous in denying any worth in his contention. Why on earth should a painter of landscapes know anything about geology? The surroundings were beautiful and the company distinguished and learned in the humanities, but the conversation was not enlightening. The instance of a figure painter was mentioned who studied anatomy diligently and yet who did not paint well, and it was claimed that the knowledge of geology cannot aid in the enjoyment of a landscape. Such were the pearls of thought contributed.

No, science has not yet been welcomed back into art. And because of this divorce proceeding men of science are occasionally found who are rather deficient on the artistic side. The cry is persistent that many good engineers lack the art of expression, and the complaint is well founded. The demand is not that they shall be able to say nothing at all with elegance and style, but rather that when they have something to say, they be able to say it. The other day there was a meeting of classicists at Princeton at which the two old idols of culture, the Greek and Latin languages, were glorified all day long as the only leaders into the graces of life. Now we know that this is not true and that compulsory classics do not make a man competent to say what he means. It is his habit of thought that gives him this, induced by training and experience in saying and reading things that are difficult to express, told with the exact, precise shade of meaning desired. This it is that gives him his intellectual background. The trouble with men who have scientific thoughts and pipe-fitters' methods of speech is not that they have failed in having been

"put through" Latin or Greek. Their trouble is more likely to be that they have graduated from local newspapers and monthly and weekly periodicals that will print any kind of idiotic pap to increase their circulation, over into physics and chemistry and mathematics. They have not engaged in refinement of thought in any language before beginning with science. And science is new, it is without traditions of expression, so that it is much more difficult to tell of reactions and processes than it is to write a sonnet. Anybody can write a sonnet; all he needs is a rhyming dictionary and the resolution to use fourteen lines to tell, for instance, that he does not like the weather when it is cold—or hot. We repeat, with time and patience anybody can do it; thousands and thousands have succeeded. But when it comes to setting forth in fourteen or twenty-eight lines either in prose or measure, so that the idea is not only correctly stated by the writer but may also be understood by the lay reader, the phase rule of Willard Gibbs, we confess that we have never heard of the genius who could do it.

Now some men are easy talkers with very little to say, while others who are among the greatest of men, would rather tackle an I. W. W. strike than make a speech. But we are not discussing oratory or talking for show. We are considering the need of clear, succinct definitions of conditions and processes that are needed in every control and every research laboratory, in every technical report and in giving commands as well as acknowledging them. There's a lot of psychology inside of most men's heads, just a little further in than their ears, and the reactions take place according to the language used.

The use of language, of our own language, is an art, a subtle but very important art that is in daily use; and it is far more needed in business than it is in idleness. Mastery of it is attained by the cultivation of a taste for it. The boy who does not try for this thing before he undertakes the more detailed preparation for his career is an ass. He will not gain it by reading stuff written to sell to those who lack it, and unless he has the industry to acquire it in the days of his youth he will sidestep along through life, always ashamed and always embarrassed by the need of it.

Decadence of the Iron Casting

It is not chance, but the orderly development of industry that has caused the iron casting to occupy a smaller and smaller place in what is broadly known as "the iron industry." The chief factor in the development has not been strength or safety, as might have been supposed. In 1899, before a meeting of one of the foundrymen's associations, a mechanical engineer of some note, lately returned from abroad, observed that he was not particularly interested in their discussions of iron foundry practice, because he had become convinced that the future of the industry lay in the steel casting. Events have proved that he was wrong. While the production of pig iron has increased three-fold since 1899, the tonnage of steel castings produced bears a relation of only 3½ per cent to the tonnage of pig iron. If safety and unit strength were the important factors the steel casting industry would have expanded much more rapidly. If it is a case of the total strength of the member the iron casting has much to commend it, for on account of size in proportion to value per pound one obtains a large radius of gyration at a low cost per pound, the iron casting being cheap for its strength even if only the outer portions are stressed.

There are no statistics of the production of iron castings, but the production of pig iron in grades used by the gray iron and malleable iron foundries furnishes an index. The statistics of pig iron production, segregated by grades, were first gathered for the year 1900. Then we have it that in 1916 17 per cent of the pig iron went to iron foundries, against 23 1/3 per cent ten years earlier and 31 per cent 16 years earlier. The figures are conclusive even though not entirely accurate as a measure of the production of iron castings. The proportions of scrap melted may have changed, but the probability is that the proportion of scrap to pig iron decreased, as the open-hearth furnace has in recent years bid favorable prices for scrap.

It is a change in manufacturing methods that has been chiefly instrumental in relegating the iron casting more and more to the background, in a sense, the greater and greater standardization. While the molding machine represented a great step it cannot compete with the press and other instrumentalities for working rolled steel into finished wares. We make things more and more to one pattern. From locks, bolts and hinges up to the heaviest articles we find rolled steel supplanting the iron casting, and indeed when we look about us to see what the largest castings are used for we find a great many of them in machinery for making or fabricating steel! In those cases the iron casting is merely digging its grave.

It has been impossible for the cost of converting pig iron into the finished casting to be decreased as greatly as the cost of converting pig iron into finished steel products because the margin was not sufficiently large at the outset. The manufacture of steel pipe, for instance, has been very greatly improved whereby when prices are low steel pipe sells for only about twice as much as cast iron pipe. Accordingly, the production of welded iron and steel pipe and tubes in 1916 was two and one-half times as large as the production of casting iron pipe and fittings, although that is one of the large items in the iron casting group.

The specialization that has fostered the use of rolled steel has not been confined, of course, to the industries that work up the steel, but has permeated its manufacture as well, whereby the old-fashioned general purpose mill has largely disappeared, to be replaced by mills that are highly specialized, continuous, tandem and otherwise. When the demand for a given form of rolled steel has doubled it has been possible to devise means for making it more economically, while that has not been the case in similar measure with the iron casting industry.

Readers' Views and Comments

Chemists in the Making

To the Editor of Metallurgical & Chemical Engineering

SIR:—An anonymous writer, whose name is not hard to guess, has been telling his fellow members of the Chicago section of the American Chemical Society, his early experiences in the practice of chemistry; setting forth his reminiscences in several issues of their monthly bulletin. He admits that he is now prosperous, but prosperity was slow in coming to him. We shall describe one of his adventures because it throws light upon some modern promotions of chemical enterprises that have come under our observation, undertaken in a similar manner.

This particular chemist had been analyzing ores in the Pittsburgh region but bad times came along and the furnaces closed down. In answer to an advertisement he accepted an offer to become the "chief chemist" of the R—— Chemical Company of Chicago, at a modest salary. Mr. R——, the founder had been reading chemical books and had discovered nothing less than wonders. It was too easy! Here were chemists, pining and sighing away for a method to fix nitrogen from the air, and there were the directions, plain as your hand before your face, all printed out in the chemistry books. It merely confirmed him in the opinion that of all blind mortals those scientific theorists were the blindest.

His epoch-making discovery consisted in this: he gathered from his reading that nitric acid was a regular old crackerjack of a solvent; that it would eat into almost anything. He made careful notes of some of the things it would dissolve and of some that it wouldn't. He also read that when an electric spark is passed through air, a certain amount of nitrogen is oxidized to nitric oxide and that with this, nothing but more air and water is needed to have it turn into nitric acid, all of itself. Then he bethought himself of the poor gold miners who dug up vast quantities of earth and rock to produce very little gold. He looked up his notes and found that nitric acid would dissolve nearly everything, as far as he could figure it, that was in the ore except the quartz and the gold. Then he proceeded to design and patent a nitric acid machine that produced a lot of sparks and had a container attached to catch the nitric acid as fast as it was made. The rest was easy. All the miners had to do was to whirl in and buy one or more of his nitric acid machines, set them up and, by making all the nitric acid they wanted, concentrate their ores right down to gold nuggets and quartz, on the spot. Nothing like it had been thought of in the way of concentrating ores before or since—in the history of man, let us add, to give the promotion twist to our language. He disclosed his secret to a friend who had done well as salesman for a wholesale grocery house and the friend threw up his job, mortgaged his house for $10,000, and came in as a partner on the ground floor. Then the company was organized, offices were taken, a campaign of advertising begun, a shop was opened up, mechanics were set to work and a draughtsman with an engineering past but too fond of drink to be steady was engaged. Orders came in and the prospects were hopeful, although the bank account was getting low and it seemed advisable to have a chemist at hand for talking purposes as the first of the apparatus drew near completion.

At this point the chemist from Pittsburgh entered and he found that not a single feature of the whole layout had been tested. He induced the draughtsman to sober up because he had a rare sense of mechanics, and the best thing the new chemist and the sobered-up draughtsman could do was to work out a plan of research that, hurry as they might, would take at least two years to reach results. They reasoned that the various effects of temperatures, pressures and other factors would have to be determined and plotted before an apparatus could be designed, and concluded that even if they made a lucky strike they would need to know under what physical and chemical conditions they obtained it. They were working in utter darkness and they urged that, before the money was all spent, they make at least a few tests.

To Mr. R—— this was twaddle, piffle, rank theory and useless and undesirable experimenting. He pointed out on page 701 of Richter's Inorganic Chemistry how part No. 1 of the apparatus was bound to succeed and on page 357 of Muspratt he demonstrated how part No. 2 could not fail. He was so certain of results that he did not even care to be present at the first trial. If his chemist and draughtsman would only do as he told them and go ahead and construct the apparatus, there would be less trouble—and less talk. The partner with the mortgage on his house stuck to his job at the office and continued to make sales for later delivery. In time the apparatus was built as designed and all the parts were connected and set in motion. After operating at capacity for two hours, delicate reagents indicated slight traces of nitric acid. It was hardly to be smelled but the slight traces—albeit no more—were proven to be there. That was the capacity of the apparatus. The chemistry books were right but the trouble was that Mr. R—— did not speak the language. He was sent for and when he arrived, according to the author, he "swore like a Turk at Muspratt and Richter—and then took everybody out for a drink."

That was the end of the R—— Chemical Company and the chemist labored long at many a task within and without his profession before he struck his gait. The type of practical men who will not submit their theories to the test is far from extinct. Many of them are still abroad in the land. It would be a dreadful insult to call them theorists; they would deny it with warmth and vigor. The term theorist is an expression of opprobrium that seldom has a definite meaning and is a word often applied by the ignorant to those who believe in looking things up before they go ahead. It would make this issue unmailable to print the practical man's usual synonym for "theorist."

E. H.

Buffalo Meeting of theAmerican Institute of Chemical Engineers

The ninth semi-annual meeting of the American Institute of Chemical Engineers was held in Buffalo from Wednesday, June 20, to Friday, June 22, inclusive, with headquarters at the Hotel Statler. It was an excellent meeting, and a most enjoyable and profitable one. The attendance was exceptionally good in spite of the urgent requirements on the members' time at present, and the members showed by their attendance, and by the discussions, that scientific meetings are extremely valuable in the present crisis, and that there are more reasons for holding them now than ever in order to co-operate with each other and with the Government to the fullest extent.

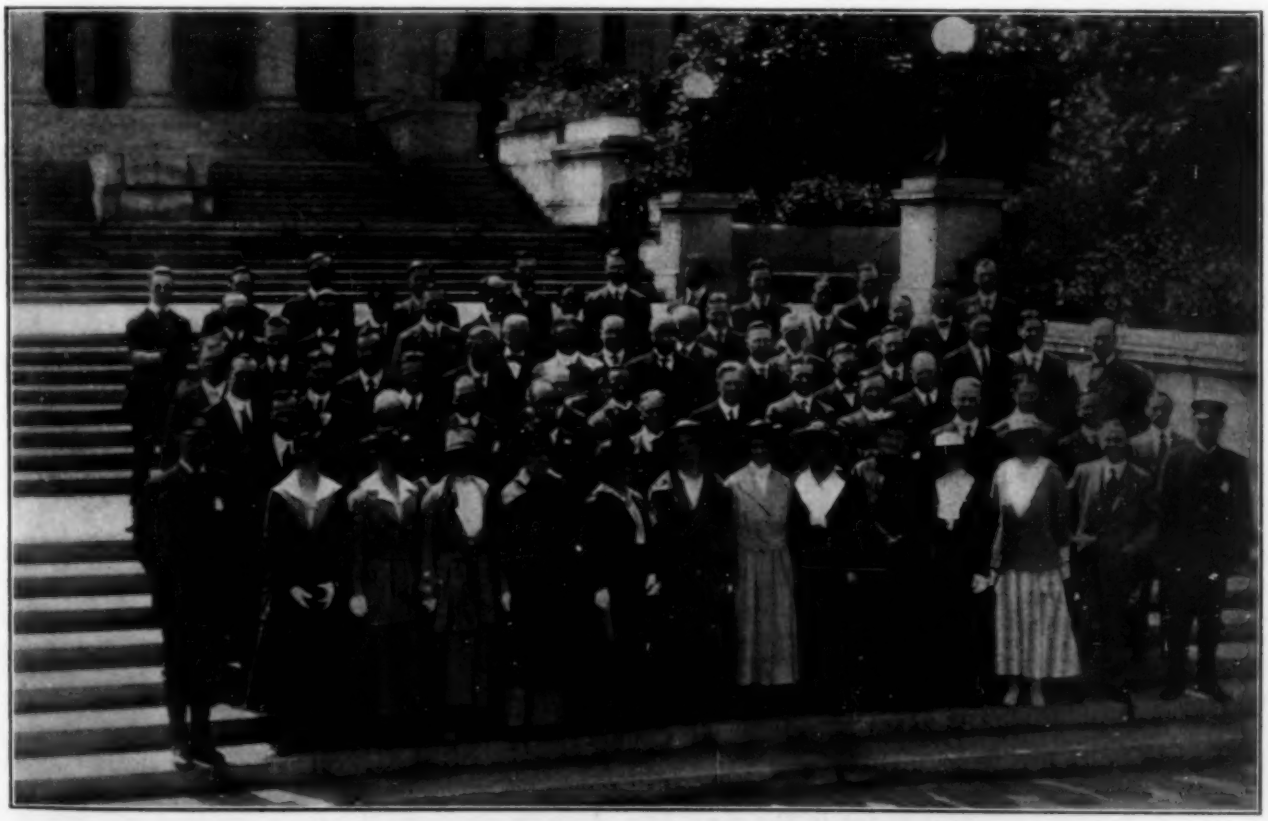
Wednesday Sessions

The meeting was called to order on Wednesday morning in the Hotel Statler by F. A. Lidbury, chairman of the local committee on arrangements, who introduced David C. Howard, first vice-president of the Buffalo Chamber of Commerce. Mr. Howard welcomed the Institute to Buffalo and outlined the wonderful industrial growth of the city which he had been in close touch with. He made a special plea for the Institute to exert its influence to obtain the right to divert more water for power purposes on the American side of Niagara Falls, on account of the great shortage of power there.

President G. W. Thompson responded on behalf of the Institute and then opened the business meeting.

The secretary, J. C. Olsen, read the report of the Council, which contained some interesting announcements. In the Council meetings co-operation with the Government had been discussed. Applications had been received for the affiliation of student societies, but it was not thought advisable to do this at present as many of the professors in charge of the societies are not in active chemical engineering work. The feasibility of establishing associate membership was also discussed, but no definite action was taken. The Council decided to recommend the appointment of a committee to consider the further adoption of the metric system. It also authorized the treasurer to invest $500 in Liberty Bonds. It was not considered necessary to take a census of all the members and their specialties, as it was thought that the Bureau of Mines census covered this.

In connection with the action of the Council on the metric system, the secretary, J. C. Olsen, announced that the Institute had sent out literature to its members of both the American Institute of Weights and Measures (opposing the metric system) and the American Metric Association. He also read a letter from Dr. Baekeland expressing surprise that the Institute had sent out circulars against the metric system, and urging the use of this system. Dr. Palmer moved that



PHOTOGRAPH TAKEN AT BUFFALO MEETING OF AMERICAN INSTITUTE OF CHEMICAL ENGINEERS

a committee be appointed to carry out the Council's recommendations. Mr. Lidbury said that the metric system should be considered by the Institute from the standpoint of the chemical engineer and not from the standpoint of the public. Professor Withrow did not think it advisable to urge the adoption of the system unless the individual membership was circularized to find out whether any would be seriously affected. Mr. Lidbury replied that it was not the intention to urge the adoption in any particular industry, but simply to go on record as favoring the system. After the discussion the motion was passed to appoint a committee.

The secretary in his report stated that the membership consisted at present of 229 regular, forty junior and one honorary member.

The report of the Committee on Engineering Education was read by Professor Withrow. He did not think that the committee could do much during the war, as many of the professors have their time taken up by the Government and by the industries. Professor Withrow made a strong plea for the continuation of all chemical education on an even stronger scale than ever during the war. He said that the Society for the Promotion of Engineering Education would meet with the Council of National Defense in Washington instead of at Northwestern University as originally planned. Means will be discussed for changing the curricula to meet war demands. The committee recommended that the Institute ask all teachers to instruct chemical engineers in the fundamentals of topography, military engineering and explosives. In the discussion on this recommendation it was suggested that the chemical engineers were so small in number that it was not advisable to teach them military engineering.

After considerable discussion on the question of keeping chemists in the industries and in their proper places, the president appointed a committee to report Friday morning, after having drawn up resolutions on this question to send to the proper authorities.

The president announced that invitations had been received from Chicago, St. Louis and Columbus, Ohio, for holding the winter convention.

MANUFACTURE OF GLUE

The first paper was presented by **A. Lowenstein** of Chicago, Ill., on "Some Machinery Employed in the Manufacture of Glue." The author stated that most of the distinctive improvements in glue manufacture had taken place in the chilling, cutting and spreading of the glue, and he confined himself to a discussion of these subjects. Glue manufacturers have been very conservative in adopting new equipment.

The old method of handling glue consists in running the concentrated solution from the evaporator into wood or galvanized-iron pans and chilling them by running water or in a refrigerating room. The cakes formed are then cut with wires or knives into blocks or sheets. They are then spread on nets.

The old methods of chilling and cutting glue require considerable space for cooling room, the pans often rust and leak, "tops" and "bottoms" are formed, and in warm weather difficulty is experienced with liquefying organisms. The author mentioned a chilling wheel used successfully at present by one of the large companies, and having brine circulated in the rim. This wheel is understood to spread a sheet 30 in. wide.

He also described the continuous method of chilling, cutting and spreading patented by Maurice Kind (1,046,307), and the machine used in this method. It consists in running the glue or gelatine from the evaporation into a head tank over a continuous belt, subjecting it to chilled air and cutting the semi-solid strips into sheets. This machine is used by a large number of glue manufacturers. It requires a space of 85 ft. by 10 ft., uses 10 hp. and 10 to 12 tons of refrigeration. The capacity is 4300 lb. of dry glue per twenty-four hours, based on spreading ¼-in. sheets and a feed containing 16 per cent solids.

In discussing the problem of drying the author stated that it is still generally done in straight tunnels with longitudinal circulation of warm air. Vacuum driers have not been very successful.

In the discussion it was asked whether any attempt had been made to use moist air in drying glue. Mr. Lowenstein replied, that to his knowledge, no deliberate attempt had been made to use moist air as it is desirable to form a skin on the surface of the glue. For this purpose dry air has always been used.

TREATMENT OF SEWAGE BY AERATION

In papers read at previous meetings the author, Prof. Edward Bartow, described experimental work with activated sludge carried out in the sewage experimental station of the Illinois State Water Survey and the University of Illinois (see *Met. & Chem. Eng.*, Vol. XIII, page 901 (1915). The removal of ammonia and the development of nitrate nitrogen were also described, and it was shown that the sludge was valuable as a fertilizer. The present paper describes further work carried out at the above mentioned sewage experimental station.

A continuous-flow plant to work on the activated sludge process and which was expected to handle 200,000 gal. of sewage and sludge per day was put in operation May 25, 1916. It was shut down June 11, 1916, to repair leaks in the concrete work. The plant was again operated from July 11 to Oct. 22, 1916, the amount of sewage added varying from 61,000 to 177,600 gal. per day. About 2 cu. ft. of air per gallon of sewage was required to obtain stable effluents.

The plant contains a screen chamber and pumping pit, a grit chamber, an aerating chamber, a settling chamber, a blower room and a laboratory equipped with sludge-drying apparatus. There is also a sludge-drying bed and a pond into which the effluent from the process may be discharged. The sewage is drawn from the main sewer of the city of Champaign.

The plant was again started Jan. 17, 1917, after cutting out the grit chamber and substituting a short box into which the sewage is pumped. It has operated continuously till the present time.

A number of experiments were carried out on different methods of air diffusion. The results of these comparative tests indicate the superiority of Filtros plates as air diffusers over perforated pipes such as used in the tests. The wooden blocks were hard to handle, partly on account of the design of the containers. They showed signs of deterioration even in the short time used. No difference could be distinguished between coarse and fine grades of Filtros plates.

It is necessary to have a practical and economical method of drying the sludge. Sand beds have not proven

successful. The sludge contains 98-99 per cent of moisture. In experiments so far filter presses have not given good results. A rotary filter containing Filtros plates was also tried, but did not give satisfactory results. A modified 8-in. basket-type centrifuge and a modified cream separator were tried. The holes of the centrifuge were covered with a strip of rubber packing. The best results with this machine were obtained at a speed of 1500 r.p.m., which was the limiting speed.

Sludge cake containing from 85 to 86 per cent of moisture was obtained by the cream separator in six to eight minutes, which showed the desirability of making further experiments. A specially designed centrifuge was obtained from the Tolhurst Machine Works of Troy, N. Y. The machine was 1 ft. in diameter, 9½ in. high, and at 1800 r.p.m. exerted a centrifugal force of 550 lb. Sludge cake containing 88 per cent moisture was made with this machine. A 40-in. machine would deliver, on the basis of the experiments with the smaller machine, about 9340 lb. of sludge containing 88 per cent moisture, or about 1100 lb. of dry material. On the supposition that ½ ton of dry material is obtained from 1,000,000 gal. of sewage, one 40-in. machine would dewater 1,000,000 gal. per day. The machine appears practical to prepare the sludge for a dryer.

In the discussion which followed Dr. Wm. P. Mason asked what the nature of the effluent was. The author replied that it usually had a turbidity of less than 5 parts per million and was practically water white. The activated sludge method has been used on stock yards waste, requiring 4 cu. ft. of air per gallon of sewage and an aeration period of eight hours. He said it takes ten days to get a new plant running well. Dr. Olsen asked what proportion of the nitrogen in the sewage was obtained in the sludge. Professor Bartow had no figures on this but thought that all the nitrogen in the sludge came from the solid material which was in the sewage.

INTENSIVE CHEMICAL PREPARATION

A paper was then read on "Intensive Chemical Preparation" by Dr. **Chas. S. Palmer** of the Mellon Institute, Pittsburgh, Pa. He spoke especially on the desirability of giving high and preparatory school students three years of preparation in chemistry, including inorganic and organic chemistry, qualitative and some quantitative analysis. He thought it would be of enormous benefit to the student in connection with his subsequent college training.

Dr. Olsen in discussing the paper said the argument was excellent for young men and women who never go to college. The average business man, banker, etc., could more intelligently support chemical and allied industries if he knew more chemistry. He thought chemistry should be made a compulsory subject in the New York City High Schools. But he said that in his experience better progress was made in chemistry in college by those students who had no chemistry in high school as the chemistry was usually improperly taught. He said the need was for not only more chemistry in the high schools but for better chemistry. The paper was discussed by several others with experience along these lines and it was the general opinion that the standard of teaching chemistry in high schools could stand considerable elevation, as in many instances the chemistry teachers were overburdened with other work.

WEDNESDAY EXCURSIONS

After luncheon at the hotel an automobile trip was taken by the members and ladies around the city through the residential sections and parks and then to the Buffalo Foundry & Machine Company's plant in the outskirts of the city. A tour had been arranged by the courtesy of the latter company which proved very interesting to the members. Booklets describing the plant and laboratories were distributed, which greatly facilitated the inspection. Each machine or piece of apparatus in the foundry and machine shop was numbered and corresponding numbers in the booklet explained each one. The company is building a large new research laboratory which will house all of the chemical, physical and semi-commercial testing laboratories. Large machining operations were first viewed, together with several large finished castings of dryers, nitrators, caustic pots, etc.

From the machine shop the party went to the plate shelf shop where welding and riveting operations were inspected. The foundry was next visited where the large castings were being poured and then a trip was made to the demonstration plant, where various small size dryers were in operation.

MANUFACTURE OF LINSEED OIL

This paper, which was read by **Glenn H. Pickard**, consulting engineer of Chicago, Ill., will be found in full on pages 12 to 16 of this issue.

In discussing this paper Dr. Wesson said the same problems were encountered in the manufacture of cottonseed oil. The chief improvements had been made in methods of cooking the seed. Dr. Thompson said the oil in the linseed cake was very different in amount in different spots and that it would be better to have the cake of even thickness.

TRADE WASTES DISPOSAL

The paper by **Harrison P. Eddy**, of Metcalf and Eddy, Boston, Mass., is published in full on pages 32 to 36 of this issue.

In the discussion Dr. Mason asked if anything had been done on the red liquor from sulphite pulp mills. Mr. Eddy had no data on this. Dr. S. P. Sadtler spoke of work being done on sterilization of tannery waste. Mr. J. V. N. Dorr spoke of a plant in Pennsylvania which had experimented with sedimentation by continuous settling. The results indicate that an overflow is obtained which complies with the law. Two 100-ft. circles are needed to take the complete output of the plant which is considered a large one. The solid material is incinerated. Professor Withrow mentioned a wood distillation plant which the authorities said was contaminating the water. They found that when the chlorine was stopped the creosote taste stopped which existed under chlorine treatment. Mr. Eddy said that no doubt under certain conditions a taste was encountered but it was less liable to be noticed when organic matter was present. This subject was also discussed by Messrs. Bartow, Mason, Snowden and Frerichs. It was brought out that hypochlorite did not produce any taste whereas chlorine did.

Thursday Sessions

The Institute was entertained all day Thursday at the Buffalo Canoe Club, near Crystal Beach, Ontario.

A steamer was taken at 10 a. m. to Crystal Beach and a launch from there to the Canoe Club. Several of the members walked along the beach to the clubhouse instead of taking the launch. The clubhouse is beautifully situated in Abino Bay, having a natural shelter from the heavy storms which are frequent on Lake Erie. The club has a private pier with two-story pavilion. The canoes are kept on the first floor, and the second floor, which is used for dancing, was given over for the holding of technical sessions. Upon arrival at the club a technical session was held in this pavilion.

SULPHURIC ACID

The session consisted of papers by Professor **James R. Withrow** of Ohio State University on the elevation and conservation of sulphuric acid and in discussion of these subjects.

Professor Withrow presented the results of some work which he had done on the elevation of sulphuric acid with waste steam, the object being to do away with air compressors. One of the methods mentioned consisted in simply substituting the steam for air in an acid egg. He said the absorption by the acid would be inappreciable in the short time during which the steam acted on the acid. Another method was to have three eggs, one for acid, one an intermediate air cushion and the third steam. In this manner no steam would come into contact with the acid. Another method was to use the waste steam to run acid pumps instead of electricity, or to have both available. Still another method was to have a sloping helical screw arrangement by which a steady stream of acid would be delivered. Steel pressure tanks can also be used in place of earthenware eggs.

Professor Withrow also spoke of the necessity of conserving our sulphuric acid to the greatest extent, as enormous quantities are needed for explosives and fertilizers and many manufacturers allow acid to go to waste because they have no concentrating system. He thought it wise to concentrate waste acid even if the operation only paid expenses, as it would furnish additional acid for fertilizers and explosives. Imports of pyrites and sulphur are not normal and the conservation of sulphuric acid is a vital necessity.

In discussing Professor Withrow's talk, Dr. Ludwig A. Thiele of Columbus, Ohio, said that elevation by steam was all right in concentration but that in the chamber process it was hard to find anything better than the acid egg. He had tried pumps of all kinds and found the greatest trouble to be with the packing. Braided lead is about the only material which will work.

Mr. Hugh K. Moore of the Berlin Mills, Berlin, N. H., asked whether anyone had ever tried making a cathode of the material used in the elevating machinery and passing a current to prevent corrosion. He had tried out a similar scheme successfully.

Mr. Arthur B. Conner of Detroit, Mich., said he thought the use of waste steam very practicable and did not see any reason why it could not be used.

In discussing ammonium sulphate for which sulphuric acid is used, Mr. Palmer said that in Germany, he understood, they were making ammonium carbonate from ammonia obtained by the Haber process, mixing this with gypsum and making ammonium sulphate. The calcium carbonate is used again to make ammonium carbonate.

Mr. Thiele said that several plants in Germany were using a mixture of calcium sulphate (gypsum), nitre cake, quartz sand and sodium sulphate for producing glass and oleum. He said 50,000 tons was being produced in this way and that it presents great possibilities. The mixture is heated in an electric furnace at 850-900 deg. C. Mr. Thiele thought that steam would have a bad effect due to heating in acid chambers. He mentioned a valveless centrifugal pump which gives good results.

Dr. Palmer said he had been recently informed that the Haber process was being used on a very large scale in subterranean passages in Germany. No one is allowed to go near the apparatus. Mr. Frerichs said he had understood that hydrogen and nitrogen were too expensive to use the Haber process and it had been kept going before the war by Reichstag appropriations. The cyanamid process was probably better. Germany uses the latter process on a large scale.

This brought up the question of power costs and Mr. Moore said that by using a steam turbine as a reducing valve with steam at 5 lbs. pressure power could be generated for $7.50 per hp. year. With steam at 250 lbs. pressure, the cost would be about $16 per hp. year.

Mr. Frerichs mentioned the Alabama River project, for which $9,000,000 had been appropriated by the Government to make the stream navigable. If $6,000,000 were added to it water can be diverted for power purposes. The Cyanamid Company offered to pay the interest on the money for being allowed to use the power. They figure $3 per hp. year as the cost. Mr. Thiele mentioned a great new power plant near Wheeling, W. Va., in the Fairmont region, where power can be generated very cheaply. It consists of a great by-product coke plant fed by gravity from the coal mines, the coal costing $1.20 per ton.

Thursday afternoon was spent in sailing, canoeing and walking. It was a most delightful day with what they call a "lady's breeze" and the afternoon was greatly enjoyed. Dinner was served in the clubhouse at 6.30 p. m. Following the dinner a technical session was held on the pier. This session had originally been planned for Friday evening but was transferred to Thursday evening and the banquet held Friday evening.

RENOVATING A SULPHIDE MILL

The author of this paper, **Dr. Hugh K. Moore** of the Berlin Mills, Berlin, N. H., presented a very interesting detailed description of work which he and his assistants had done at LaTuque, P. Q., Canada. The work was done in connection with renovating and reconstructing a pulp mill running on the so-called sulphate process. The paper was a splendid example of what chemical engineering can do and publication of this paper in full is reserved for a later issue.

In the discussion Doctor Palmer asked what the cost of coal was at that point. Mr. Moore replied that it was approximately $5 per ton. Mr. Harry O. Chute mentioned a multiple effect evaporator used in evaporating brine. Deposits collected on the tube which he thought consisted of magnesium sulphate.

He thought the acetylene method of removing this mentioned by Mr. Moore would have saved considerable money.

Owing to the lateness of the hour and to the necessity of taking the boat back to Buffalo it was decided to

postpone the reading of Mr. H. D. Baylor's paper on waste heat utilization until Friday morning.

The party returned to Buffalo on the 9 p. m. boat, arriving in Buffalo about 10.30.

Friday Sessions

The meeting was called to order Friday morning by President Thompson, who asked for a report of the committee appointed on Wednesday to draft resolutions urging the government to keep chemists and chemical engineers in their proper spheres. Professor Withrow read the resolutions which had been drafted. The substance of the resolutions was as mentioned that the American Institute of Chemical Engineers urges the exemption of chemists and chemical engineers unless their chemical ability is needed. The resolutions were unanimously adopted.

It was decided to send a telegram to President Wilson and other authorities if advisable, stating that the resolutions had been passed and explaining the reasons.

WASTE HEAT FROM CEMENT MILLS

A paper by **H. D. Baylor** of Sellersburg, Ind., was read by title as the author was unable to be present. The paper discussed the use of waste heat boilers with cement kilns at the Louisville Cement Co., Speeds, Ind. The gains realized were as follows:

(*a*) The decrease in fuel required to burn a barrel of cement from approximately 110 lb. per barrel to less than 100 lb., this being largely due to the preheating of the air for combustion by drawing it over the hot clinker and also in having the coal feed under absolute control.

(*b*) An increase of general efficiency of heat absorption from 37.6 per cent to 67.2 per cent of total heat supplied to kilns, the gain being shown in the boiler horsepower developed without an increase in fuel consumed in kilns per barrel.

(*c*) The recovery of at least one half the dust that was formerly carried out the kiln stack.

(*d*) And last but not least, the solution of draft control on the kilns through the use of the large induced-draft fan. This alone is quite worth while, since cement engineers seldom agree as to size and shape of kiln stacks; but with the variable fan speed obtainable each authority can have just the draft that best suits his conditions.

In discussing the paper President Thompson mentioned a smelter having fourteen reverberating furnaces, each one connected to a boiler, the boilers being connected to a common header. These boilers furnish power to run all the fans and one handling machinery. Dr. Moore said that the radiant heat furnishes a great deal of the heat furnished to waste heat boilers. Mr. Meade said that the problem was an old one but that recent success was due to the higher velocity of the gases.

POTASH RECOVERY FROM FELDSPAR

A paper on a new method of potash recovery from feldspar by Prof. **J. P. W. Frazer** and Dr. **E. Miller** of Johns Hopkins University, Baltimore, Md., was read by Dr. Miller. The paper described the results of experiments made last year in the production of potash and aluminum. Feldspar is treated with alkali forming a compound analagous to leucite, which can be leached. The feldspar is ground and mixed with 8/10 of 1 per cent by weight of potassium hydroxide. The hydroxide is used as a solution. The mixture is then evaporated to dryness and then heated to 200 to 300 deg. C. The leucite product is insoluble in water, hence the product is then leached, dissolving out the alkali. This solution is regenerated by treating with lime. The artificial leucite contains all the potash, the treatment simply taking out one molecule of silica. This artificial leucite is then treated with acid, any mineral acid sufficing. Methyl orange is used as an indicator. If hydrochloric acid is used an amount is taken equivalent to the potassium in the leucite. The end product from this leaching is analogous to kaolinite. This is treated with sulphuric acid and aluminum sulphate is obtained. The authors claim that the yield of potassium chloride is theoretical and that the yield of aluminum is about 86 per cent. A feldspar containing 10 per cent potash will yield ¼ ton of 80-per cent potassium chloride to one ton of aluminium sulphate.

THE AMERICAN POTASH INDUSTRY

A paper on the possibilities of developing an American potash industry was read by **Richard K. Meade** of Baltimore, Md. Publication of this paper in full is reserved for a later issue.

POTASH FROM BEET SUGAR FACTORIES

Mr. **H. E. Zitkowski** presented a paper on potash from waste liquors of beet sugar factories which will be found published in full on pages 17 to 19.

In the discussion on the potash symposium Mr. H. K. Moore said that evaporation was important in some processes. He thought that it did not pay to have more than four effects. By putting the liquor in the last effect and working backwards better results are attained. He is at present designing a 10-effect evaporator for concentrating digester liquor. He thinks that in the beet sugar industry backward evaporation would solve the problem as high final heat does no harm.

Mr. Thiele said that more time should be spent in exploring the country for potash deposits. The subject was also discussed by Messrs. Meade, Toch and Chute.

FRIDAY EXCURSIONS

On Friday afternoon the members and ladies were taken in automobiles to Niagara Falls. A stop was made on the outskirts of Buffalo at the Curtiss aeroplane sheds and a flight was witnessed. A special trolley car was provided in Buffalo to take the party around the gorge route. This car was furnished by the courtesy of the Buffalo Foundry & Machine Company. After the trip was over the party went to Goat Island and refreshments were served. The party returned to Buffalo about 7.30 p. m., the banquet starting about 8 p. m. The banquet was very well attended and excellent speeches were made. It was a fitting ending to a most successful meeting. President Thompson acted as toastmaster. F. A. Lidbury spoke of the chemists' obligations in the war and of several things that are being done. Prof. Alfred W. Smith of Case School of Applied Science, Cleveland, Ohio, spoke of the relation of education to the war. Prof. W. P. Mason gave an amusing talk on "temperance" and told several funny stories. Maximillian Toch gave a very interesting talk on the

various activities in which chemists are taking part during the war.

Great credit is due the local committee for the splendid entertainment features. F. A. Lidbury was chairman, David Bell had charge of the autos. David C. Howard was vice-chairman and Benj. H. Bonnar was responsible for the splendid Canoe Club outing Thursday. Other local committee members were W. M. Corse, C. M. De Forrest, Henry Russell, W. H. Watkins, and John Younger.

Coming Meetings and Events

American Chemical Society, Boston, Sept. 10-15, 1917.

Third National Exposition of Chemical Industries, Grand Central Palace, New York, week of Sept. 24, 1917.

American Institute of Metals and Foundrymen's Association, Boston, week of Sept. 24, 1917.

American Electrochemical Society, autumn meeting, Pittsburgh, Oct. 3-6, 1917.

American Institute of Mining Engineers, annual meeting, St. Louis, Oct. 8-13, 1917.

Scientific Meetings in War Times

A number of our scientific societies have deemed it advisable "on account of the war" to either cancel or postpone their future meetings and conventions. The American Electrochemical Society disapproves of this action and at its recent board meeting adopted resolutions encouraging the holding of meetings.

Modern warfare is not so much a matter of prowess at arms as it is a stupendous engineering undertaking. To hasten this war to an early and victorious close our many thousand engineers must bring to bear every possible effort. However, individual, independent effort is not desirable at this time: *concertive* action is absolutely essential for the most efficient service.

In order to expedite the solution of many of the new problems that have arisen as a direct consequence of our martial state, unrestricted discussion of the problems (with but few exceptions) at scientific meetings is bound to give all of us a clearer understanding of the real points at issue, of the urgent needs of our country at this momentous hour.

Meetings of scientific and technical societies have ever served as a great stimulus for their members and have been a "clearing house" for many of the best thoughts and ideas of our professional men.

Let us follow the good example set us by England. Let us encourage rather than discourage the holding of scientific meetings in these war times. When England found herself confronted with a very serious shortage of sulphuric acid, glass, dyes, electrodes, brass, furnaces, etc., the scientific societies arranged symposiums on these subjects and invited not only all of the members to attend but further, urged those factory men who were not members to come to the meetings to give their views and experiences and to learn all they could in return.

Just as a large business corporation depends upon the organized effort and efficiency of the several units and departments, so does our government, now more than ever, look to the organized concertive effort of its large engineering bodies for quick and efficient results. Let us continue holding our meetings and hold them more frequently than ever before.

COLIN G. FINK.

Granular Carbon Electric Furnace

By Samuel A. Tucker

A very useful furnace for maintaining temperatures considerably above those possible with the usual wire-wound furnace has been constructed in our laboratories.

There is a furnace on the market which operates with a granular carbon resistor, but the refractory parts are complicated and it is sold at such a high price that it is less useful than such a piece of apparatus should be.

The design here shown in Figs. 1 and 2 is simple to construct, the parts are inexpensive, it will reach a high temperature in a short time, energy consumption is not great, and the heated space is perhaps larger than is usually found in such furnaces. One difficulty in using a circular granular carbon resistor is in the tendency to uneven heating, particularly at the start. This furnace is therefore provided with four electrodes, as shown in the sketch.

The furnace body, 12 in. x 12 in. x 9 in., is of fireclay, with opening as shown. This particular shape was used because it happened to be in the laboratory; however, such a body could have been taken from one of the usual gas crucible furnace parts which are to be obtained on the market. Four holes are bored to admit the elec-

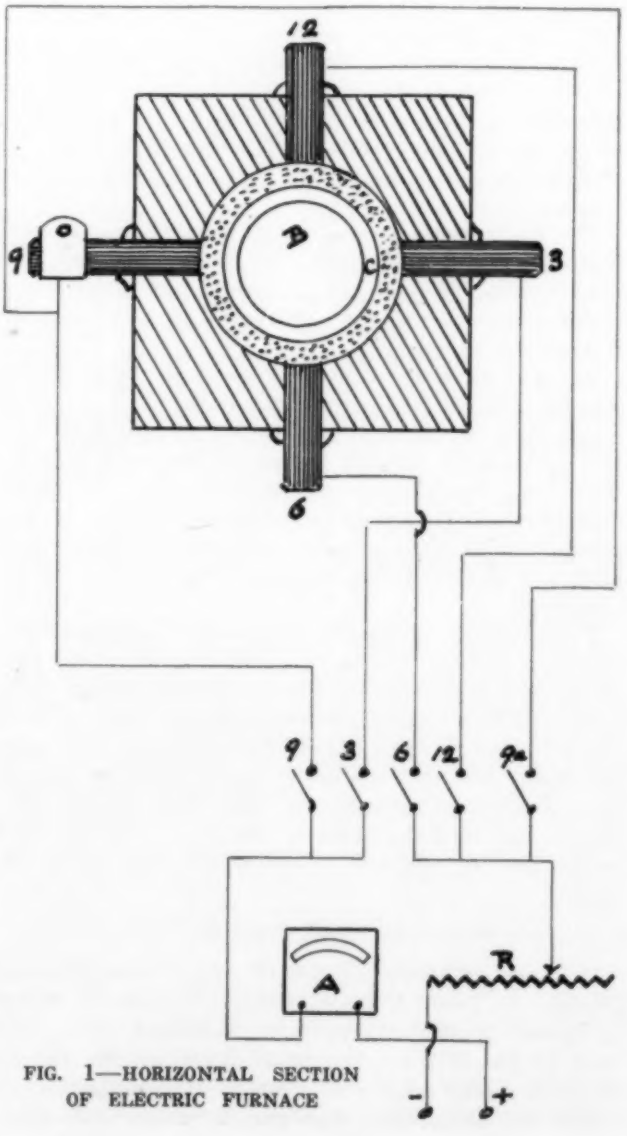


FIG. 1—HORIZONTAL SECTION OF ELECTRIC FURNACE

trodes about 1 in. diameter to the open space *B;* this space is partitioned by the carborundum ring *C*, which is 4 in. outside diameter, 3 5/16 in. inside and 3¼ in. high. This gives an annular space for the granular carbon connecting all four electrodes.

Granular carbon was obtained from the National Carbon Company, the size of grain being about 20 mesh, and was filled in to the top of the refractory ring.

The ring itself was constructed as follows (Fig. 3): Carborundum ground fine in a ball mill was mixed with

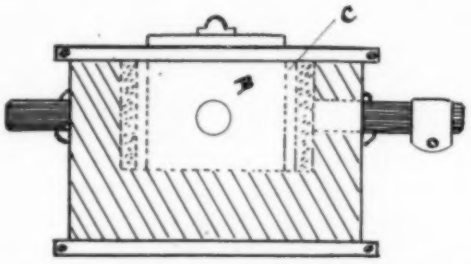


FIG. 2—VERTICAL SECTION OF ELECTRIC FURNACE

25 per cent fireclay and enough water added to make a thick mass. This mix was then tamped in to the cardboard mold shown in the drawing. The inner form at 1 and 2 is made by wrapping the cardboard on wood form 2 and holding it on the wood with small tacks or glue.

The outer form at 3 is also of cardboard held on the wood base projecting up inside the cardboard cylinder, as shown by the dotted line, and strengthened by the wood block at the top. In this way the form can be made quite strong enough and at the same time is sufficiently porous to permit of the drying out of the mixture. After thoroughly drying in a gas oven at 110 deg. C., it is transferred to a gas muffle and thoroughly baked at a temperature of 900 deg.-1000 deg. C. The mold is of course lost, but it is so easily made that it is of little consequence. The ring so constructed is quite strong enough for the purpose intended, and furnace cover, etc., may be made in the same way. Electrical connections are made as shown in the diagram from the five switches with wire of about 50-ampere carrying capacity. On closing switches 9, 3, 6 and 12 we have adjacent electrodes of opposite polarity and a short time will suffice to show whether the ring is heating evenly. Should this not be the case, and one quadrant appears to be too hot, this can be cut out by opening the switches for that position. When all have become evenly heated 9, 6 and 12 are opened and 3 and 9a closed, by which arrangement it acts as a two-pole furnace, which is the normal manner of running.

The following figures give a run with such a furnace using direct current at 120 volts through variable rheostats *R:*

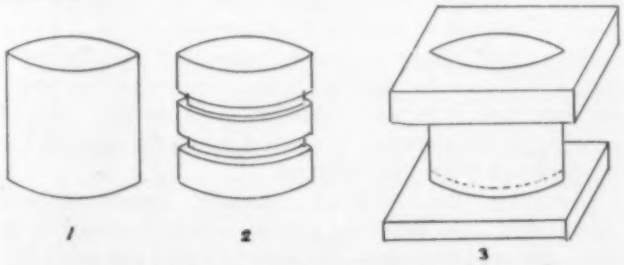


FIG. 3—CONSTRUCTION OF RING

Time	Amps.	Volts	Temp. Deg. C.	Remarks
9.30	25	..	....	4 pole
9.40	40	..	500 }	Changed poles
9.50	38	..	700 }	to regulate
10.00	12	..	720	2 pole
10.10	36	..	900	2 pole
10.20	18	98	1,000	2 pole
10.30	22	110	1,090	2 pole
10.40	23	98	1,200	2 pole
10.50	28	97	1,275	2 pole
11.00	24	98	1,300	2 pole
11.20	22	97	1,300	2 pole
12.00	22	97	1,300	2 pole

The furnace was covered with a carborundum disk and further with asbestos board with a small opening to allow the introduction of the thermocouple. In another case the furnace reached 1400 deg. C. in forty-five minutes using 50-60 amperes at from 51 to 53 volts.

It is necessary to have the electrodes fitted well to the openings provided in the body, and this can be done by wrapping with thin asbestos paper and luting with asbestos fireclay cement from the outside. Iron bands are necessary to clamp the body to prevent cracking.

The furnace described by A. W. Fahrenwald* is a very interesting design which has about the same purpose as this one. We have not had time to construct one of this type, but hope to do so in the near future, possibly changing the dimensions to permit of a larger working space and in this way can compare the advantages of each.

We believe that the refractory parts can be made for either type of furnace by the method here described, which would obviate the necessity of buying expensive alundum tubes, and it is possible that the carborundum parts would answer the purpose better than alundum.

Electrochemical Laboratory,
Columbia University.

American Society for Testing Materials

Annual Meeting at Atlantic City

The annual meeting of the American Society for Testing Materials opened on Tuesday, June 26, at the Hotel Traymore in Atlantic City. President A. A. Stevenson, vice-president of the Standard Steel Works, Philadelphia, Pa., presided.

On Tuesday morning the report of the executive committee was read. The membership is now 2167 as compared with 2071 last year. The translation of standard specifications into foreign languages has been delayed but the first ones are expected soon. Officers elected for the coming year are as follows: President Gen. W. H. Bixby, retired, Washington, D. C.; vice-president, Prof. Edward Orton, Ohio State University.

Tuesday evening was devoted to a reception and to the annual presidential address. Addresses were also made by all of the six past-presidents who, singularly, happened to be present. President Stevenson, in his address said: "The steel industry of the nation is drafting into its service all the newest inventions, labor-saving devices, intelligence and executive ability that can be employed in meeting the unprecedented call for steel products. Forty million tons were manufactured last year. That exceptional record will be exceeded this year, and extensions of plants are being hurried. The steel industry realizes the important part that it is to play in aiding the nation in winning the war. He outlined a plan for securing national standards through a committee made up of representatives of five national engineering societies.

*This journal May 15, 1917, page 565.

The Manufacture of Linseed Oil*

By Glenn H. Pickard

Practically all of the flaxseed or linseed crushed in America is handled in the open-plate hydraulic press. Until recently a small proportion of the oil was won by the extraction of the seed with naphtha, but with the recent destruction by fire of the last plant operating on this principle, the process, so far as linseed oil is concerned, ceased to be in this country. The expeller is employed in a few mills, but the amount of oil produced by this means is a very small proportion of the whole.

CLEANING OF SEED

The first step in the manufacture of linseed oil from flaxseed is the cleaning of the raw material. The removal of the foreign matter in a consignment of seed is accomplished by specially designed flax screening machinery which employs the usual method of passing the grain over screens of proper sizes which separate, as completely as possible, the foreign matter from the flax seed. A current of air removes the chaff. This procedure will reduce the percentage of impurities to an amount lying between 1 and 2 per cent. The screenings are generally run through a separator, and the wheat, corn, oats and possibly other grains are sold as such, while the wild buckwheat, pigeon grass, wild mustard and other valuable weed seeds are sold to feed manufacturers.

The presence of oleagenous seed would deleteriously affect the quality of the linseed oil because the oils yielded by them are non-drying. The extent of the damage would naturally vary with the amount present. Non-oleagenous matter, particularly immature seeds and bits of the plants, impart a dark greenish color to the oil. The presence of much foreign matter will reduce the yield by absorption. It is economically possible to clean to such an extent that from but one to 2 per cent of impurities remain.

CRUSHING OF SEED

The cleaned seed is now crushed by passing it back and forth between rolls which are built in stacks of five. They are usually made of chilled steel and are 14 in. diameter by 48 in. long. The journal boxes are loose in vertical guides so that the weight of the other four is carried by the bottom roll. The seed passes between rolls four times and at each successive passage the pressure is increased by the weight of an additional one. The top, middle and bottom rolls are driven by power applied by rope or belt drive as the case may be.

The object of the crushing is to disintegrate the seed, thus breaking down the cell walls preparatory to expression of the oil. Consequently, subdivision to the greatest possible extent consistent with economy is the best practice. Generally all of the rolls travel at the same rate so that there is no grinding or mulling action to assist in the disruption of the seed itself.

Stacks of rolls have been built in which the speed of each varied, thus producing a grinding action by slippage at point of contact. No data are available to show whether or not an increase in yield resulted.

Given a standard set of rolls the two important variables are the revolutions per minute and the rate at which the seed is fed. Practice in both varies. Obviously the more rapid the rate in both instances the poorer the grinding will be. Observations have led to the conclusion that the crushing of about 10½ bushels per hour at a roll speed of 150 r.p.m. is the most economical practice on rolls 14 x 48 in.

TEMPERING OR HEATING OF LINSEED MEAL

In order that, when placed under pressure, the ground seed may more quickly, more easily and more completely give up the oil it contains, it is heated with or without the addition of moisture. This is accomplished in the heater or cooker, the unit of which is a cylindrical chamber with a steam jacket on the bottom and around the sides. These cookers vary in diameter from 42 to 84 in. Linseed oil mills are generally equipped with 72 or 84-in. cookers. The depth of the chamber is about 24 in. From two to four units, one above the other are generally used. In each receptacle there is a sweep which lies very close to the bottom in order that the meal may not lodge there and burn. The shaft to which these sweeps are attached is hollow. A finely perforated pipe is fastened to the back of the sweep and is connected to the opening in the shaft. Through this system steam may be admitted to the meal.

There are two practices followed, one in which the two-unit cooker is employed and steam is led into the meal in the upper chamber. The amount of steam varies with the moisture content of the seed. The feed is so regulated that the meal chambers are not full providing space above which allows evaporation to take place.

The other method is to use the "three" or "four" high kettle, adjust the feed so that the whole apparatus is full all of the time and admit no live steam at all except possibly when crushing old, dry seed which is hard to soften.

The factors entering into this operation are the speed of travel of the meal, and consequently time under heat, the temperature to which it is heated, and the amount of moisture present. If the time is too short the tissues are not thoroughly softened and the yield is low as a result.

When the temperature is low the yield falls and the cake is brittle and easily broken; if it be too high the cake has a characteristic and undesirable odor and the oil will be dark and in certain uses will cause trouble.

Too little moisture yields a crumbly non-adherent meal which will not pack well and from which the cake is unsatisfactory. If too wet the meal is soggy, the oil contains an excessive amount of moisture and the cake will be dark in color and tough.

We have, therefore, three factors to coordinate in the tempering or heating of linseed meal. The only means of control are the senses of the operator. He takes a handful of meal and compresses it. If it has a certain "feel" under pressure, packs in a definite manner, and oil can be started by the pressure of the hand, he says that it is well tempered. He modifies one or another of the elements of control, when the cake or the meal varies from his standard.

Obviously the personal equation causes marked fluctuation. No two men are in complete accord upon fundamental principles. No accurate data are available, if indeed any exist, on which to base a system. Little

*A paper read at the Buffalo meeting of the American Institute of Chemical Engineers, June 20, 1917.

is known of what really happens in the tempering operation. The theory is that the combined heat and moisture break down the walls of the oil cells, coagulate the albuminous sediment forming portions of the seed and reduce the viscosity of the oil, thus making it possible for the flow to be more quickly and easily accomplished under pressure.

Of the mechanism of the changes within the ground flax seed, or of the manner in which variations in operation bring about the results noted in practice, little or nothing is known. It does not appear to be a difficult matter to apply scientific methods of observation during the process with the view of securing means of definite and positive control so that variations in raw material may be made convergent in the meal cooker and so that uniform efficiency of extraction and uniform products may result.

THE FORMER

From the bottom of the lowest compartment of the heater the meal passes into a metal box mounted on a runway over which it travels to the "former," a machine which measures the amount of ground seed to constitute the charge for each of the plates of the press and compresses it to a soft cake. These formers are actuated by hydraulic, by steam or by belted power. The hydraulic type, the one commonly used, is operated from the low-pressure hydraulic system.

At the end of the runway on which travels the meal box is a hinged flapper frame on a table which moves at right angles to the travel of the box so that it may be pushed back under the stationary part of the machine. This consists of a head block of heavy cast iron supported by wrought iron pillars, designed to withstand the upward pressure of a base plate actuated from below by a hydraulic ram. During the operation a slide gate in the bottom of the cooker is opened by hand to allow the box to fill with meal. On the table is laid the press cloth in a strip about 15 in. wide and 6 ft. long.

The buggy box is now filled with meal and pulled out over the frame into which most of its contents fall. It is generally given two passages over the frame to insure an even filling of the space. Considerable skill is acquired by experience in the handling of the box in order to produce a clean uniform fill with the material evenly placed and of constant weight. The table is now pushed back under the head block, the power applied for an instant, then released, the table withdrawn and the flapper frame is lifted. The ends of the cloth are thrown over the top of the formed cake when the pressman slips a sheet of iron pan slightly larger than the frame and equipped with a handle on one end under the cloth and transfers the molded and wrapped cake to the press box. This type of former minimizes danger of injury to the operators because it is practically impossible to get one's fingers in a position where they will be crushed.

To do good work a former must mold a perfect and compact cake that will fit the press boxes, must work cleanly, that is, not spread the meal out to litter up the press room, must make a cake sufficiently coherent to permit of necessary handling without loss of portions of it and must deliver a cake of uniform density and thickness so that uneven pressure will not be caused in the press and uniform cakes will result after pressing.

There is a mechanically operated buggy box in which the box is on the end of a piston actuated by hydraulic power. The machine lacks the uniformity resulting from the effort of a man interested in doing good work because it will not run the meal box over the frame twice in order to have it evenly filled and thereby make a cake of uniform density. It doubtless, however, compares favorably with the work of green or indifferent operators. It does not make a reduction in labor expended because a man is required to operate this machine and to do the other work necessary to form and wrap the meal just as when all hand power is employed.

THE PRESS

The press used in the winning of linseed oil is the typical open-plate hydraulic machine, the essential parts of which are: The cylinder and lower block, frequently cast in one piece; a stationary head block which is bolted through to the lower block by means of heavy hammered iron columns; and the ram, on the end of which is placed a platen or heavy block rigid enough to prevent flexure at the ends so that even pressure will be exerted over the entire plate area.

Hydraulic pressure is obtained from power-driven pumps so equipped as to be capable of supplying both high and low pressures. One of the most popular forms of pump is a four-crank design furnishing both pressures. The hydraulic system consists of a supply tank for the liquid, which in this case is linseed oil, pumps, accumulators, valves, change cocks and piping. The accumulator is of heavy material superimposed upon a ram and guided in its vertical movement. Its object is to store hydraulic fluid which is intermittently used, thus producing more constant load on the pumps, to steady the pressure by reducing shocks which, if severe, would injure the machinery and piping, and to act as a regulating valve to maintain a uniform pressure. Both the high-and-low pressure systems have an accumulator. The low pressure is used to start the working stroke of the press and to operate the "former," the packer and possibly the other hydraulic machinery. It is usually set at 500 lb. per square inch. The high pressure varies between 3500 and 4500 lb.

The regulation of the presure is this: When there is no demand for fluid the plungers work idly by circulating the oil through and back to the supply tank by means of the automatic movement of a valve from a system of adjustable rods and levers at the accumulator. When working fluid is again required the by-pass valve is closed by the fall of the accumulator and the pump again delivers fluid at working pressure. When communication is opened to a press through an automatic change cock the pressure is turned onto the ram only from the low-pressure accumulator. The press ram travels up rapidly until a pressure of 200 to 300 lb. is reached, which is enough to start the oil. A choker in each pipe regulates the speed of the press by throttling the flow of the fluid. The ram travel is slowed down in proportion to the escape of the oil. When a pressure of 500 lb. is reached the oil from the high-pressure accumulator is automatically turned on to the press ram. The speed of travel is again governed by a choker so that the maximum pressure of about 4000 lb. is not reached until the ram is nearly at the end of its travel.

Press plates are at present generally made of rolled steel about ⅝ in. thick. They were formerly made of iron or of brass. The sizes of the plates vary, although in linseed oil manufacture they are generally designed to hold a cake 13 x 32 in. or 16 x 34 in.

Drainage is secured by cutting grooves or oil channels close to the edges of the plate which are pitched toward the rear where they connect with down spouts that conduct the oil to the receiving troughs at the floor level behind the presses. Some presses are tilted back to give a fall sufficient to cause the oil to run in that direction.

Suspension of the plates, when pressure is released, is usually obtained by the use of links, each set of which carries the plates beneath, unless sectional supports are provided. The links are of two sorts, the plain open type, or the square, flat-headed type. The former are fastened to T-headed bolts screwed onto the edges of the plates while the others are slipped into notches out in the sides of the plate near the ends. Often the plates are divided into groups so as to lighten the load upon the links. This is accomplished by having lugs on the plates which engage the heads of screws set at proper intervals in the columns.

Another very effective method of support is by a step ladder or inverted V-shaped device the feet of which are fastened into the columns near the bottom plate, while the top is attached to the head block at the center of each side. The legs of the ladder are of steel plate and are notched at measured intervals.

Into each side of a plate are screwed two headless bolts so placed that each engages its own step of the ladder. Thus, each plate is supported by a rigid frame and the load caused by a group of plates is done away with. The wear on the steps is slight and easily adjusted, for when the press is up the supporting frame can be removed and repaired without removing the plates, while when the links are used each plate must be removed whenever it is necessary to shorten them.

It is important that the links be kept true, for they control the space between plates which must not fall below a minimum or the cakes cannot be placed easily. It is a too frequent occurrence, especially in new mills, to have the cake space shortened by wear or lengthening of the links so that the bottom cake is not easily put into proper position causing uneven pressure and the breaking of the platen. It is false economy to reduce the cake space in designing a press, for time is lost during loading and cakes are not evenly placed causing them to lie at angles instead of parallel to each other. This means uneven pressure and loss of oil. With ample working space the molded and wrapped cake is quickly placed into proper position, thus lengthening the time of pressure and insuring even pressure throughout.

CAPACITY OF PRESSES

Primarily the capacity of the press is controlled by the number of plates comprising it, though variations in operation, to be discussed later, are factors of the capacity of any given press.

The number of plates in the presses of American mills varies, generally between sixteen and twenty-six. The obvious objection to the small presses is low capacity, for when reduced below twenty plates little if any gain in yield results. When the large twenty-four and twenty-six-plate presses are employed it is hard to find men tall enough to reach the top plate and agile enough to place the bottom one quickly. A slight additional expense is noted with large presses caused by the destruction of the ends of the slip pans which are broken by the exertion of downward pressure before they are entirely out from between the plates.

When a large number of cakes are replaced the press is down a longer time and consequently cooled more. The temperature of the press and its contents has an important bearing upon the yield, consequently the lower it drops the lower is the extraction. It may be said that the meal can be raised to a higher temperature, but this is an undesirable thing to do for there is a limit beyond which meal ought never to be heated.

Further, when the number of plates is large, there is a correspondingly great mass through which the pressure must be exerted. When this goes beyond a maximum excessive cushioning occurs and low yield results. The extent of the loss caused by the use of large presses is an unanswered question, though one capable of easy solution.

No data are available which show, with all other variables constant, the effect that the increase in the number of plates has upon the yield of oil. What might be called circumstantial evidence—that is, the comparison of the percentages of oil in the cakes produced in mills known to have large and small presses—shows the latter to be more efficient. However, other factors enter which could account for the difference. It is the opinion of many versed in the operation of linseed mills that the twenty-plate press combines the greatest number of elements that make for efficient extraction.

PRESS MATS

A much mooted subject in linseed oil manufacture is that of press mats. These are mats woven from rope of coarse hair such as that from the manes and tails of cattle. They are fastened to the plates, which are often roughened to prevent slippage. Frequently the mats are attached to a screen of coarse mesh and heavy wire, which are in turn made fast to the plate. Mats of malleable iron are also used, which are bolted to the plate. In many mills mats are used on both top and bottom plate; in others on but one, and in still others none at all are used.

The statement has been made that the mat was originally used to form a porous material through which the oil could run after leaving the meal. Practice, however, has proved that the presence or absence of mats makes no difference with the flow of oil.

Supporters of the use of mats now claim that they tend to make the transmission of pressure equal at all points. If properly molded, the cakes will lie evenly on the plate and consequently be subjected to an even pressure without the assistance of a mat. It is also hard to see how a mat can even up the exertion of pressure in view of the normal causes of that action.

In answer to the statement that mats rigidly grip the press cloth thus preventing slippage and uneven tension on it, can be placed the experience in two mills which has been directly communicated to the writer. In one there were two sections, one equipped with double hair mats and the other with none. After years of parallel operation the superintendent made the statement that press cloth costs were the same in both cases.

In another mill strips of sheet iron were placed over the mats with a consequent slight reduction in the cost of press cloth.

Hair mats are poor conductors of heat, hence, it is said, the temperature of the meal will be reduced to a lesser extent during the pressing operation, and therefore the yield of oil will be increased. In the previously mentioned mill that section equipped with hair mats produced no more oil than did the bare plate portion.

With only conflicting statements available, and these based upon data doubtless modified by other variables effective during the period of observation, it is impossible to state positively what the hair mat does or does not accomplish. The objection to their use is cost. They are expensive and need frequently to be replaced.

The mat does serve to guide the slip pan into proper position when the soft cake is slipped in between the plates, thus insuring equal pressure and parallel plates. The malleable mat accomplishes this without expenses save the initial cost. When bare plates are used they are corrugated or cut at right angles to prevent slippage while under pressure.

Another objection to mats is that they are thick enough appreciably to reduce the cake space in a given column height. When bare plates are used there are fastened along the sides near the edge strips of metal beveled on the inside. These are to serve as guides in filling the press and also to prevent the meal from being pressed out at the edges. If they are made high enough effectively to guide the pan they cut the press cloth.

THE PRESS CLOTH

One of the relatively large items of expense in linseed oil manufacture is that of press cloth; that is, the material which is wrapped about the cake when molded. It is usually woven from camel's hair because of the elasticity of that fiber and its ability to retain its strength and form under high pressures and temperatures. At present, this material is very high in price and is scarce as well. Various mats of wool and mixtures of wool and camel's hair cloth are being tried, but preference would still be given to the camel's hair. Press cloth of human hair is now available. First tests of this showed up very well against camel's hair.

The avoidance of those elements of press room practice which make for the rapid destruction of press cloth is essential to good work. Trouble can start in the heater for water balls, or an uneven heating or wetting of the ground seed will gum up the cloths in spots, thus preventing the flow of the oil through them and causing disruption at that point. Meal not uniformly temperated does not pack evenly, producing tension on the cloth. If too much moisture is in the meal as molded it forces its way into the cloth, fills up the interstices with consequent tension and tearing. Too high a temperature will reduce the tensile strength of the fibers and breaking will result.

If the "former" does not produce a cake of uniform density the uneven packing in the press causes stresses which result in torn cloth. The press room foreman must watch the rate of ram travel after the oil begins to flow, for if it is too fast the volume of oil set free, much of which passes to the edges through the cloth, will tear it. This must be watched with extreme care when the pressing takes place at a low temperature as in starting up after a shut-down.

The torn cloths are darned, patched, mended and pieced until the waste comprises short strips which are beyond redemption. These are but typical causes for too rapid destruction of press cloth. Constant watching by intelligent men is necessary to keep down this item of expense.

THE FUNCTION OF THE PRESSURE, CAKE WEIGHT AND TIME

In the pressing of the tempered meal in a given press there are three variables which are functions of yield and capacity; one is the pressure. That most generally used is from 3500 to 4500 lb. per square inch. A gage should be placed on each press so that close watch can be kept for unexpected variations.

Another variable is the weight of the molded cake. Practice varies between those weighing 10 lb. after pressing and those of 15 or 16 lb. When the cakes are thick the mass of meal under pressure is great, there is more tendency toward uneven packing and the cushioning in the press is at a maximum.

As in the case of the number of plates in a press there are no authentic data available on the effect of variations in the cake weight upon oil yield, and so again we draw our conclusions from the analysis of light and heavy cake without knowing that weight was the only variable. The light cake gives the lowest average oil content. The minimum weight produced is 10 lb. To keep as close to that as possible is a good practice.

The third variable is time. The presses are usually arranged in groups of six, one of which is operated by the two or three men who work together. Assuming such to be the case the pressings per hour are expressed as six on six, seven on six or five on six, as the case may be.

In the first case the pressure is exerted for sixty minutes less the time required to discharge and charge, which varies between five and ten minutes with the dexterity of the men. The seven on six method allows but fifty-one minutes, while five on six permits of seventy-two minutes under pressure less changing time.

In a mill which operated six on six part of the year and seven on six the remainder, a careful analysis of the cake produced is always kept. A tabulation for a period of several years showed that the longer time increased the oil in the cake by one-half of 1 per cent. With cake at $30 per ton and oil at 50 cents per gallon, ½ per cent reduction in the oil content of the cake makes a gain of 2.5 cents per bushel of seed, or $3.25 per press per day when it is run for yield and not capacity. To-day the figure would be about 9 cents per bushel.

As a result of a study of the data on hand supplemented by experience the writer would use, with the feeling that he was not far from the most economic practice, one roll for each two presses, an 84-in., three-high heater for twelve presses, or possibly a 72-in. to six presses, a hand-operated hydraulic former and twenty-plate presses in which 10-lb. cake would be produced at the rate of six pressings per hour on each six presses.

The obvious conclusion to be drawn from the statements made is that the manufacture of linseed oil is controlled in an uncertain empirical manner. It is possible that a system could be worked out by accurate

observations of the effect of various changes in operation and by a scientific study of the underlying reactions and mechanical principles involved which would minimize the effect of variations in the seed and thus render extraction more efficient. With the present and probable prices of oil and cake for the near future one would not have to make much of an improvement to pay large dividends upon the investment required.

DISPOSING OF THE CAKES

When the cakes are removed from the press they are stripped—that is, the wrappers are removed. This is done either by hand or by machine. It is hard, disagreeable work, for at the start the pull is mostly on the fingers and the cake is hot. The mechanical strippers in use simply catch the end of the cloth when it is placed in contact with a revolving shaft about which it is wound.

The stripped cake is now sent to the trimmer, where the soft edges of high-oil content are cut off. Trimmers are of two types, those with revolving knives and those with stationary knives, both having spring tension devices. There is little choice in effectiveness. The rotary knife takes more power and is more complex, but the trimmings from it do not need regrinding, while those from the stationary knife machine do.

The depth to which to trim depends upon local conditions. It should be determined at each plant from its operating cost so that the yield of oil from the trimmings when recrushed will be enough to repay the expense of handling. If trimmed too deep the oil content will be so low that the oil recovered will cost more than it is worth, while if too much oil is left in the cake by shallow trimming oil loss results. About 12 per cent oil in the trimmings is right when normal conditions obtain.

If to be sold as such, the cakes are packed generally in second-hand sugar bags and shipped. A hydraulic machine takes a pile of cake from the trimmer and pushes it into a bag, which is loosely filled, then the bag is placed under a packer which jams single cakes into it until the strain is near the breaking point.

When ground to meal the cakes are run into an impact mill direct or into a breaker and then an attrition mill. The first method is generally considered the more economical.

THE OIL

When the oil runs from the presses it is caught in settling troughs or deep metal boxes in which coarse particles settle to the bottom. From here it goes to filter supply tanks. Filtration is accomplished by the plate and frame press. The filter medium varies from light sheeting to heavy duck and from light to heavy paper. At some mills the oil is filtered warm through cloth, sent to storage and then refiltered just previous to shipment. With many the second filtration is omitted. Others allow the oil to cool without the first, or, as it is termed, "scalping," filtration, and then pass through cloth or paper.

Any one of these practices will remove the suspended particles of seed and deliver a clear oil. However, moisture and materials taken into colloidal solution from the seed are present in larger amounts in warm oil. They gradually precipitate as the temperature falls forming what is known in oil parlance as "foots." Therefore the temperature of the oil at time of filtratin is an important function of its quality. If single filtration is determined upon, excellent results may be had by allowing the oil to cool and then passing it through cloth or paper, preferably the latter.

The quality of raw linseed oil is obviously dependent upon the manner of its filtration. Further, too high a temperature in the heater darkens the oil and causes it to dissolve more material from the seed. A hot pressed oil will darken more under heat, will not bleach so well in the refinery and shows other deleterious effects of the high temperature.

The quality and cleanness of the seed have a marked influence as well. Seed selection for oil quality is unknown, because no means at present exists to connect the characteristics of perfect flax seed with the quality of oil contained.

An investigation of this problem is at present under way. We are hopeful of results that will enlighten us upon the effect of seed strain, soil and climatic conditions, upon the quality of oil and possibly enable prediction from an examination of flax seed of the quality of its oil.

The manufacturers employing linseed oil demand of that product specific qualities such as pale color, high content of fatty acids, proper action in the varnish kettle and high speed of polymerization when subjected to high temperatures. These qualities are imparted by chemical treatments of various sorts which are more or less secret and which involve only simple mechanical equipment and operation.

During the last five years the average oil content of clean seed received by a mill on the seaboard was 39.02 per cent. North American seed comprised 75 per cent of that crushed, the rest being South American. Assuming that the cake will contain 5.5 per cent, an amount attainable by good practice, the theoretical yield of a cake will be 36.15 lb. and of oil 19.86 lb., or 2.64 gal. of 7½ lb. each. The word "theoretical" is used because there is a manufacturing loss of about 2 per cent. This is nearly all due to the evaporation of moisture, though some is accounted for by soakage, dusting and similar causes. If the moisture in the seed is high the loss will be above normal for oil carries very little water, so that the cake must contain all that is in the seed or a loss is inevitable.

Chicago, Ill.

German Alcohol.—At the annual meeting of German spirit manufacturers, recently held in Berlin, it was stated (according to the *Chemical Trade Journal and Chemical Engineer*) that all the departments of the manufacture had been busy with general and special war work. The outlook for the future was not considered favorable, since for years to come potatoes would more than ever be wanted as food; a great many of the large farms used to rely more upon potato-spirit distillation than upon farm produce. For incandescent burners alcohol with 15 per cent of benzene is being utilized; in fuels, alcohol with 25 per cent of benzene is substituted for petroleum. The sale of petroleum for illumination is at present forbidden in Germany. Acetone fermentation works had been opened in Arenberg, but the technical difficulties of the process had not been quite overcome yet; it is also intended to manufacture by fermentation of butyl and other alcohols.

The Recovery of Potash from Beet Sugar House Waste Liquors*

By H. E. Zitkowski

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The recovery of the residual values from beet sugar waste liquor has been the subject of serious investigation even prior to the war. However, the abnormally high potash prices of the past few years have brought about renewed efforts in this direction.

The fundamentals for a consideration of this problem are the following:

During the 1916 season approximately 6,000,000 tons of sugar beets were produced in the United States. In all probability a materially greater tonnage will be produced this year, and the possibilities for increased production in the immediate future are promising, though this phase of the problem is so intimately related to the tariff, the agricultural labor supply, and ruling prices of other agricultural products that prophecy is fruitless.

The composition of the beet, and therefore its content of potash, is variable from season to season and in different localities and soil conditions. The following analyses of beets from three widely separated localities in the United States can serve as a basis.

	Colorado Per Cent	California Per Cent	Wisconsin Per Cent
Moisture	78.36	63.99	74.37
Dry substance	21.64	36.01	25.63
Ash (carbonate)	0.89	0.88	....
Total nitrogen	0.199	0.254	0.1817
Sugar	15.40	25.60	18.7
Mineral matter in per cent in beets:			
Cl	0.102	0.065	0.040
SO_3	0.028	0.034	0.024
P_2O_5	0.046	0.121	0.023
K_2O	0.320	0.269	0.320
Na_2O	0.097	0.106	0.089
CaO	0.032	0.078	0.041
MgO	0.058	0.051	0.047
$Fe_2O_3Al_2O_3$	0.042	0.014	0.027
SiO_2	0.005	0.016	0.036

Both the California and Wisconsin samples were several days in transit to the laboratory at which the analyses were made, and undoubtedly lost considerable moisture by evaporation which consequently increased the percentage content of dry matter. Aside from that the California sample was abnormally high in sugar content.

From an agricultural and economic viewpoint—aside from the sugar—the nitrogen, phosphoric acid and potash content of the sugar beet is of more than passing importance.

Accepting the average of the three analyses herein reported as the average for the entire production, the 6,000,000 ton crop of beets of 1916 contained of

Nitrogen	12,700 tons
Phosphoric anhydride	3,780 tons
Potassium oxide	18,180 tons

Investigations indicate that in extracting the sugar values by the diffusion process approximately 60 per cent of the nitrogen and 90 per cent of the phosphoric acid and potash content are extracted with the sugar and pass into the process, the rest remains with the pulp. As this pulp now is completely utilized for live stock feeding purposes, the plant food values of this pulp are not lost to agriculture except in so far as farm yard manures are inefficiently utilized.

Of the plant food values extracted and now in the juices phosphoric acid is completely eliminated as calcium phosphate, and to date largely wasted. A part of the nitrogen content is eliminated as coagulated protein and otherwise, together with the phosphoric salts. The potash, however, is not eliminated from the juices by the usual processes of purification and is found in the final molasses, that is the mother liquors, from which sugar cannot be further recovered by direct crystallization, and for this the presence of potash salts are partly responsible.

The production of molasses from beets is somewhat variable from season to season, but an average percentage production for the United States will be somewhere between 5.5 per cent to 6.0 per cent on beets. With a 6,000,000-ton crop of beets this totals to 330,000 to 360,000 tons.

A study of a series of thirteen samples of American beet molasses as reported in Volume 18, No. 4, of *Sugar*, indicates an average content of 1.69 per cent nitrogen and 4.66 per cent of potassium oxide, K_2O.

On this basis the beet sugar molasses production of the past campaign contained between 15,400 and 16,700 tons of K_2O, which checks fairly closely with the figures above estimated. Of the total beet molasses production, under normal conditions perhaps 5 per cent, under present conditions double this amount or more, is used in alcohol production and the still residues, containing the potash, are concentrated and usually enter the fertilizer trade and are therefore, not lost to the general economy.

Approximately 40 per cent of the total molasses production is used for stock feeding purposes, in part direct as such, but by far the greater part is mixed with some absorbent feed, frequently beet pulp either fresh or dried, and also many of the fodders. The potash values in this case are recovered in proportion as the manureal values from these feeding operations are recovered.

The remainder of the United States molasses production, perhaps 45 per cent of the total, during the past season from 148,000 to 152,000 tons, is desugarized, that is sugar is extracted in marketable form. It is this portion of the beet crop that contains the possibilities of potash production in commercial form at the sugar factories.

The process now used almost exclusively in this country in extracting sugar from this molasses is known after its inventor as the Steffens precipitation process in which sugar is precipitated as tri-calcium saccharate.

Essentially the procedure is as follows:

Molasses of about 80 per cent solids is diluted to 10 per cent to 12 per cent solid content, cooled to about 15 deg. C. and under suitable means for cooling and stirring, finely powdered calcium oxide is dusted into the solution. If the conditions essential to the process are adhered to 90 per cent or more of the sugar is precipitated as a calcium compound and is removed from the mixture by filtration.

The filtrate, now with a content of solid matter of 5 per cent to 7 per cent contains practically all of the potash originally in the molasses and also variable percentages of sugar not precipitated above.

The sugar in solution is probably present in the form of dicalcium saccharate $C_{12}H_{22}O_{11}\cdot 2CaO$. If this cold filtrate is heated to 85 deg. C. approximately 60 per cent of the sugar in solution is precipitated as a calcium saccharate probably according to the following reaction:

*A paper presented at the Buffalo meeting of The American Institute of Chemical Engineers, June 22, 1917.

$$3C_{12}H_{22}O_{11}\cdot 2CaO \leftrightarrows 2C_{12}H_{22}O_{11}\cdot 3CaO + C_{12}H_{22}O_{11}.$$

The reaction is reversible and on cooling the saccharate formed dissolves. It is necessary to filter at the precipitation temperature.

This, known as the hot saccharate process, is now quite generally used to recover additional sugar values from the solution which are not readily and economically recovered by the first step or cold process.

The filtrate, now known as Steffens hot waste water, still contains from a few hundredths to four or five tenths of a per cent of sugar, some lime and practically all of the potash and most of the other non-sugars present in the molasses. This is the waste liquor forming a potential potash supply.

In several instances, where the sugar company controls agricultural lands in quantity adjoining the factory, these waste liquors, together with other residues, are used to irrigate the lands. This is perhaps the most economical method of utilizing the residual values as all of the potash and phosphoric acid and nearly all of the nitrogen of the beet can be returned to the soils, but this is practical only in isolated instances, and only about 8 per cent of the total beet crop is handled in this manner.

In still other of the irrigated sections where the residual waters are discharged into existing streams and the streams are subsequently diverted for irrigation purposes some of the values may be inadvertently utilized, but in any event the losses to the economy of the state must be very considerable by this method of disposal.

In most cases the waste residues are sent into settling basins, the clear effluent of which reaches the streams and is carried away. Efforts had been made even before the war to recover these values, and owing to the stimulus of high potash prices of recent years the work in this direction has been followed with more than usual vigor. However, the problem has its difficulties.

The hot waste water as produced is very dilute containing 96 per cent or more of water, it is necessary to concentrate it. As produced it contains 0.2 to 0.5 per cent of free lime, CaO, which will foul the evaporating surfaces if not removed. This is readily enough accomplished by carbonating (injecting CO_2 gas) and filtering. (It might be stated that during the past campaign in one case these waters were concentrated by the direct gases from an oil fire passing upward through a sheet metal gradier over which the waste liquors flowed. In this case removal of the lime was not necessary as the heat transfer was brought about by direct contact without an intervening metallic surface. This method of evaporating is prohibitive as to costs under normal conditions.)

The carbonated and filtered waste water varies in composition with the season, locality, and factory practice, but the following is typical.

	Per Cent
Moisture	97.00
Dry substance	3.00
Carbonate ash	1.00
Sugar	0.30
Organic non-sugar	1.70
Nitrogen	0.16
K_2O	0.35

This indicates at once that the content of values is low, the cost of evaporation comparatively great, and also that under normal conditions, when the value of a unit of nitrogen is two or three times that of a unit of potash, the nitrogen values are as great or greater than those of the potash contained in these waters. Up to a content of 50 per cent to 55 per cent dry substance this water can be readily enough concentrated in multiple-effect evaporators, and quadruple and also quintuple-effect evaporators have been used very successfully. With a content of more than 55 per cent dry matter the liquor begins to salt out and foul the heating surfaces. However, beyond this point the material can be readily enough concentrated still further, and brought to a dry state by the use of one of the various types of vacuum drum dryers. The trouble is to keep the material dry.

The dried material containing 10 to 12 per cent of K_2O and 5 per cent N. is so exceedingly deliquescent and absorbs atmospheric moisture so readily that it becomes fluid in a very short time.

Various absorbents have been used to overcome this difficulty, one of the most successful being dried slaughter house wastes which incidentally are deficient in potash, so the two materials complement one another. Ultimately this may prove to be a direction in which considerable quantities of the sugar factory waste waters will be utilized, but unfortunately only few beet sugar factories are now located within a reasonable distance of the meat packers and the cost of freight enters.

In some localities small quantities of 50 to 55 per cent dry substance have been disposed of in tank car lots directly to the agricultural industry as a liquid fertilizer. In other instances it is urged to sell the liquid fertilizer direct to the farmer, the farmer to saturate his barn yard manure with the concentrate and thus use it. It is doubtful whether material quantities can be disposed of in this form at present.

With present potash prices the nitrogen values have lost their relative value with the result that in at least one instance these have been sacrificed in order to obtain a product comparatively high in potash content, which would permit its shipment considerable distances to the potash-consuming centers.

When the Steffens water is concentrated to about 55 per cent dry substance owing to its high content of sugar, and other organic matter, it can be quite readily ignited and charred, its own content of combustible matter then furnishing most of the necessary heat. The char, or crude ash thus produced contains from 30 to 35 per cent of potassium oxide, but only traces of nitrogen. This procedure is economically justifiable only with present potash prices. In other directions experiments are being made toward a recovery of the potash salts in comparatively pure form, and still save the nitrogen values.

That roughly covers the efforts made in the recovery of the values of the beet sugar liquor residues.

Technically the recovery of the potash values from these liquors is a comparatively simple and perfectly feasible problem. It is simply one of evaporating the dilute liquors as economically as practical, charring the residue to produce the crude ash and leaching and recrystallizing if this is desired. The quantities of water to be evaporated, however, are large, the necessary equipment costly, and commercially such a procedure has possibilities only during war prices.

Now it is true that almost any sugar factory could have paid for a potash recovery plant in one year with present potash prices, but the war may end any time and leave a lot of very costly equipment on hand, es-

pecially as the cost of such equipment, evaporators, boilers, etc., is abnormally high at present. Then also a beet sugar factory operates seasonally only, the average length of the operating season is only about 100 days, and the earnings must be made during this short period. But at that some progress is being made, and at least one concentrating plant is under construction and several others under consideration and more of the values will be recovered during the 1917 campaign than during the past.

However, in these instances a recovery of all the values in the liquors is aimed at, not the potash values only. This will be touched briefly below.

Approximately the disposition of the potash in the sugar beet crop grown in the United States at present is as follows:

Returned to farms in pulp.....10 per cent
Found in molasses produced.....90 per cent

The potash found in molasses is distributed as follows:

To alcohol plants.....10 per cent plus
Used as molasses feeds.....40 per cent plus
Desugarized .....45 per cent plus

This only leaves under control of the manufacturers about 40 per cent of the potash content of the beet which on the basis of a 6,000,000-ton crop amounts to between 6800 and 7500 tons of K_2O.

This quantity is now disposed of as follows:

Directly to the soil as factory sewage..20 per cent
Concentrated to 50-55 per cent dry substance and sold to fertilizer factories 5 per cent
Concentrated and calcined to a crude ash ..... 5 per cent
Discharged into streams and representing the stock of values now lost.....70 per cent

Thus far the subject has been considered from the angle of recovering the potash for the chemical industries or the potash and nitrogen as fertilizers only. That does not by any means exhaust the possibilities. Beet sugar molasses and therefore the waste water contains a great number of substances which in themselves are valuable or may serve as the mother substance for valuable product. The possibilities can here be touched on only very briefly.

Even in the case of potash and nitrogen it appears from the experience of Europe that the general economy is served best by combining these into a more valuable product. From Germany it is reported that by the Bueb process of destructive distillation the waste liquor of molasses desugarizing processes operating by the strontium process, in that country, produce annually 5000 tons of potassium cyanide and 5000 tons of ammonium sulfate. Steffens waters can be similarly utilized and a United States patent has been granted for such a process.

The molasses waste liquors contain a whole series of organic acids valuable to industry which can be recovered.

The nitrogen of these waste liquors occurs in various forms, partly as a plant basis of which the principal is betain, which has found some application in medicine. A large part of the nitrogen content exists in the form of amido acids. These it has been shown by Effront can, by suitable fermentation processes, be split into ammonia and a mixture of volatile fatty acids, acetic, propionic, butyric. Recent investigations in this country indicate that a mixture of the high boiling point ketones valuable in cellulose technology, can be prepared from this liquor.

Ehrlich insists that the amido compounds present in considerable quantities in beet molasses waste liquors are the mother substance of fusel oil, more particularly amyl alcohol, and suggests extracting these compounds and utilizing them to increase the fusel oil production. This indicates only a few of the possibilities. While it is not claimed that beet molasses may yet prove another coal tar, chemically it may be almost as interesting.

But little has been done in developing the waste liquor values in this country. The reasons are various. Not the least lies in the fact that sugar is a sort of national and international political football. Between duties, bounties, premiums, special international agreements as the Brussels Conference, and competition with the tropics, the beet sugar industry in the United States has never felt sufficiently safe to venture into new directions.

At the outbreak of the present war the outlook was particularly dark. The tariff had been lowered, and a duty free sugar clause enacted to go into effect May 1, 1916. Fortunately, this latter clause was repealed before going into effect.

What the development of the future may be will depend more upon legislation following cessation of hostilities rather than present high prices, and in this respect the beet sugar industry is not differently situated than most other chemical industries in this country.

American Beet Sugar Co.,
Rocky Ford, Col.

Metallurgical Processes in the Foundry*

Use of Ferromanganese, Ferrosilicon, Chills and Iron Molds

By Alexander E. Outerbridge, Jr.
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Before proceeding to the subject proper of my paper I wish to make a little confession. After almost a lifetime spent in the study and daily practical application of investigations in metallurgy on a somewhat large scale, more particularly in cast iron in industrial works, I feel sometimes that I know less about the subject to-day than I thought I did nearly 40 years ago. This is not surprising, however, for I believe it is the universal experience of investigators that the more one delves into Nature's mysteries the more one finds to discover, thus relatively, the more one studies the less one feels that he knows.

The history of the study of astronomy affords, for example, a striking illustration of this. Long before Galileo pointed the first telescope at the heavens, in 1609, the old monks had, with infinite pains, mapped out the firmament and recorded the positions of all the stars then visible to the eye of man and they naturally thought that their charts were complete. But the moment the new and more powerful eye of the telescope was pointed at the blue vault hundreds of thousands of starry worlds came into view whose existence had never before been suspected, revealing glowing stars so far distant that the light from them must have started on its long journey centuries before the Christian era.

*An address delivered before the Philadelphia Foundrymen's Association on June 6, 1917.

So it is with more mundane affairs, such as the study of the composition and physical properties of metals and alloys. Chemistry has told us pretty well the elements and proportions of the components of complex alloys, like cast iron, but that is, after all, a very dim light to guide us and it only reveals a few of the most conspicuous properties, leaving many others yet to be discovered by those who come after us.

In comparatively recent years the microscope has supplemented chemical analysis and has given us much valuable information regarding the effect of heat treatment upon the structure of metals especially iron and steel. The spectroscope also has shown us the signatures of all metals, written in fine lines of colored lights that cannot be imitated or disguised.

The specific gravity of alloys and the remarkable changes in density that may be effected by heat, as in the case of the extraordinary growth of gray cast iron when subjected to repeated heating and cooling* or the equally remarkable change in density caused by sudden cooling from the liquid to the solid state, as shown in the tread or periphery of a chilled cast iron car wheel are subjects of great interest for study. These are but a few of the aids to the study of metals now available and a vast unexplored field yet remains for the future investigator.

The difference between wrought iron, steel and cast iron, is commonly attributed mainly to the proportion of carbon, silicon, sulphur, phosphorus, manganese, together with a few other elements, composing these alloys, and the analytical chemist has no difficulty in determining the relative proportions of these elements with sufficient accuracy, but beyond this lies a region of which he knows nothing. He does tell us, it is true, that carbon exists in iron in two different forms, "combined" and "graphitic," but how many other forms of carbon may there be united with these other elements?

Take pure carbon alone, we already know of no less than three totally different forms, viz.: (1) A soft, intensely black substance called "lamp black" which the chemist tells us is 100 per cent carbon; (2) An intensely hard transparent crystal, the diamond, also 100 per cent carbon; (3) Pure plumbago or graphite, an unctuous material, quite different from the other forms, also 100 per cent carbon. There is absolutely no chemical difference between them.

In like manner it is known that pure silicon exists in three distinct forms or amorphous conditions. So it is with some and probably all of the other elements combined with iron.

The chemist or physicist is not yet born who can, by any known methods of investigation, state with positiveness—or even guess at—the various possible forms or combinations of the elements composing these alloys and it is not, therefore, surprising, that oftentimes the analyses of two specimens of iron, steel or other metals, will be nearly alike, when the physical properties are very different.

*Two bars of gray cast iron were shown that were cast in one mold from one ladle and were both originally the same size, viz., 14 13/16 x 1 x 1 in. The specific gravity of the metal was 7.21, making 450 lb. to the cubic foot. One bar had been permanently expanded or caused to "grow" while in the solid form to 16½ x 1⅛ x 1⅛ in., making an increase of 40 97/100 per cent. The specific gravity of the expanded bar is 5.54, making 350 lb. to the cubic foot. These identical bars were first shown before this association in 1903. Other bars of gray cast iron have been caused to increase in cubical dimensions over 50 per cent by repeated heating and cooling, still retaining their metallic qualities.

These are a few of the problems I have been studying for nearly forty years, but you are, of course, interested mainly in the practical side of such questions, hence we will now descend from the realm of theory to that of practice.

A number of cast iron test pieces made to illustrate an address given by myself before the Franklin Institute in 1888 on "The Relation Between the Physical Properties and Chemical Constituents of Pig Iron" are shown in Fig. 1. Here are shown test pieces cast

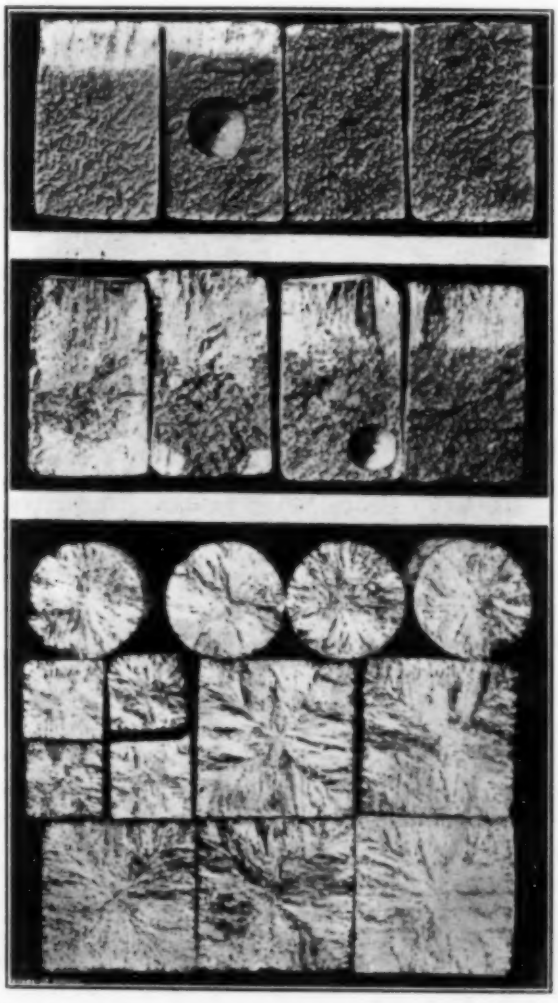


FIG. 1—TEST PIECES CAST IN SAND AND IRON MOLDS

from eight different melts of iron. The two upper rows were poured in green sand molds having an iron chill block on one face.

The test bar at the right hand upper corner shows merely a "skin chill' on the part cast against the iron block, the next bar shows a very little more chill, the other bars show increasing proportion of white iron on the upper faces and two show white iron on the lower faces also. Beneath the eight test pieces cast in sand, you see nine square and four round test pieces, all perfectly white iron, showing very clearly that the crystals are always formed at right angles to the surface of the mold. These test pieces were cast in iron molds from the same ladles of iron as the other bars and you will notice that all are equally white, notwithstanding the fact that the bars cast in sand with an iron chill block on one face vary enormously in depth of chill.

These iron molds may be called "chill magnifiers." I

have used similar chill cups daily for detecting chilling properties in soft foundry irons for over thirty years, and they have proved to be of the greatest value in detecting chill that would not otherwise be suspected in such iron mixtures.

The main difference in composition of the eight melts of iron shown in this plate was found to be in the relative proportion of silicon.

The test piece showing a mere trace of chill has over 1½ per cent silicon, the one showing the most chill has about 6/10 of 1 per cent silicon, the other test pieces contain silicon ranging between these extremes.

The manufacture of chilled cast iron car wheels, (Fig. 2) a purely American invention, to which the development of railways in this country may be said to owe its rapid progress in the early days and to which it is still largely indebted for freight traffic, was rendered possible by the practical application of the chilling property found in our cold blast charcoal irons, and its continued success to-day is dependent largely upon the skill of the chemist to simulate those natural qualities by other means, long after cold blast charcoal iron has gone out of existence.

My first investigation of this peculiar property of cold blast charcoal iron (and of some grades of anthracite and coke iron) dates back to the year 1876, when a fine exhibit of chilled cast iron car wheels at the Centennial Exhibition first attracted my attention. One of the wheels was broken to show the fracture; the plate and brackets were dark gray, while the tread of the wheel was white as silver. On inquiry I learned that the white iron tread was formed by sudden cooling of the metal cast against a heavy iron "chill ring" and that while the plate and hub of the wheel cast in a green sand mold were quite soft the tread was hard as steel.

At that time I was making some specific gravity determinations of various metals in the assay laboratory of the mint, where I was an assistant, and samples of the white iron forming the tread of a wheel and of the dark gray iron forming the body were furnished to me for examination. I was astonished to find that the white metal weighed about 60 lb. to the cu. ft. more than the gray iron portion of the same casting.

This served to explain the abnormal cooling strains in a chilled casting of this character, necessitating prolonged annealing, or very slow cooling, to enable the molecules to adjust themselves gradually and thus relieve the strains.

These investigations led to others and for a period of eight years I was daily engaged in the study of the metallurgy of chilled cast iron car wheels and their manufacture. It was customary to cast, each day, in the car wheel works where I was engaged as metallurgist, a large variety of chilled car wheels ranging from full size, double-plate passenger and freight wheels, 33 in. diameter, street car wheels (usually of spoke pattern) down to small and light mine car wheels.

FIG. 2—SECTION OF 33-INCH CAR WHEEL CAST FROM TREATED IRON SHOWING FINE WHITE CRYSTALS AND DARK GRAY

It was not possible to pour all of these from one mixture of iron for the metal suitable for the heavy wheels was too high chilling for the smaller wheels. This necessitated melting soft iron every day in a small cupola to mix in varying proportions with the regular iron in separate ladles.

To overcome this expense, if possible, by altering the character of the iron in individual ladles, after delivery from the cupola, a great many experiments were made (1880-4) with aluminium (then costing $8 per pound), spiegeleisen and 80 per cent ferromanganese, granulated or powdered, added in small quantity to the metal in the ladles.

The effects produced by aluminium and spiegeleisen were in the right direction though they were not sufficiently marked to be valuable but it was then found that when powdered 80 per cent ferromanganese was added in the proportion of 1 lb. to 600 lb. of iron in a ladle, a most remarkable change was immediately produced in the character of the molten iron in the ladle. The first publication of these experiments was given in the address already alluded to, printed in the Journal of the Franklin Institute, March, 1888, and was as follows:

"A remarkable effect is produced upon the character of hard iron (i.e., high chilling iron) by adding to the molten metal, a moment before pouring it into a mold, a very small quantity of powdered 80 per cent ferromanganese, say 1 lb. in 600 lb. of iron. The result of several hundred carefully conducted experiments which I have made enables me to say that the transverse strength of the metal is increased from 30 to 40 per cent, the shrinkage is decreased from 20 to 30 per cent and the depth of the chill is decreased about 25 per cent, while one-half of the combined carbon is changed into free carbon."

Prior to this time manganese had always been regarded as a hardening element in cast iron, and the surprising claim that when added in a ladle of high-chilling car-wheel iron it had an opposite effect at first met with incredulity, but in course of time its use became almost universal, and I believe it still is used very largely in the manufacture of chilled cast-iron car wheels. No application for patent rights was made for this process.

Ferromanganese, when added in powdered form to a ladle of molten car-wheel iron, acts as a deoxidizing and desulphurizing flux by reason of the strong affinity of manganese for oxygen and sulphur, but it is only efficacious when added to iron that is comparatively low in silicon (less than 1 per cent) and high in combined carbon.

It is absolutely useless, if not positively harmful, when added to foundry mixtures carrying over 1 per cent silicon and but little combined carbon, yet I know that 80 per cent ferromanganese has been sold to foundrymen for treatment of their foundry iron mixtures during the time when the alloy could be bought for a few cents a pound. Its present price is prohibitive, except for special purposes.

The use of ferromanganese as a flux in ladles in car

wheel manufacture is of enormous value to that industry, its abuse through ignorance or failure to understand its proper functions must have led to disappointment when added as a flux in ladles of foundry iron by those who do not understand or appreciate the radical difference between car-wheel iron and foundry iron, whether soft or hard.

While the manufacture of chilled cast-iron car wheels requires very accurate control of the chilling property of the metal, it is of far more uniform character than the iron needed for the great variety of castings, ranging from a few pounds up to perhaps 30 tons or over that must be melted often in one day in the large machine tool works with which I am connected as metallurgist. It is customary, therefore, to group all the small work needing soft ductile iron so that it will be cast near the beginning of the run of iron from the cupola, this is followed by a medium grade of iron for miscellaneous castings capable of being machined readily, but not too soft to give good wearing service; this again is followed by strong iron mixtures intended for large and heavy work requiring metal of high tensile and transverse strength.

The importance of having some simple, cheap and reliable method of changing the physical properties of molten iron after it has been tapped from the cupola has been regarded as a desideratum ever since the value of the method of modifying the chilling property of car-wheel iron in individual ladles by treatment with powdered ferromanganese became well known. This led, as I have stated, to improper use of ferromanganese in ladles of foundry iron through ignorance of its proper functions.

As long ago as 1880 I made efforts in this direction with alloys of iron and silicon, but at that time the richest alloy obtainable contained less than 20 per cent silicon.

In later years, 50 per cent ferrosilicon was produced in electric furnaces for use in steel making, and these tests were then renewed with the results that have been already published, showing that the addition of a small quantity of the powdered 50 per cent ferrosilicon alloy in a ladle of molten foundry iron produces a remarkable effect upon it by softening and at the same time strengthening the iron. This is quite an opposite effect to that produced by increasing silicon in the cupola, which always tends to weaken iron.

The following table shows the results of a few tests of this kind made in 1905 with ordinary foundry irons (Table I):

The effect of adding 4 oz. of powdered 50 per cent ferrosilicon in a hand ladle holding about 25 lb. of molten iron, and of adding 1 lb. to 200 lb. of iron in a ladle, upon the strength and deflection, as compared with the same iron untreated, is clearly shown in this table. The success of these initial tests led to more extended investigations.

TABLE I—RESULTS OF TESTS OF FERRO-SILICON IN LADLES

Date	Remarks per Cent Si	Breaking Strain (Lbs.)	Deflection (In.)	Resilience	Shrinkage (In.)	Per Cent Gain		
						Breaking Strain	Deflection	Resilience
Oct. 10, '05	¼ lb Hand Ladle	2265	.120	45.30	.192			
	2155	.112	40.09	.191				
	Gain	110	.008	5.21		5.1%	7.14%	13%
Oct. 11, '05	¼ lb Hand Ladle	2215	.137	50.51	.182			
	2165	.124	44.60	.185				
	Gain	50	.013	5.91		2.3%	10.4%	13.2%
Oct. 14, '05	½ lb Hand Ladle	2600	.152	65.79	.196			
	2055	.116	39.18	.188				
	Gain	545	.036	26.61		26.5%	31%	67%
Oct. 15, '05	¼ lb Hand Ladle	2330	.143	55.45	.183			
	1893	.110	34.60	.183				
	Gain	437	.033	20.85		23.8%	30%	60.2%
Oct. 16, '05	¼ lb Hand Ladle	2210	.124	45.54	.183			
	2120	.112	39.44					
	Gain	90	.012	6.10		4.2%	10.7%	15.4%
Nov. 13, '05	1 lb 200 lb Ladle	2370	.130	54.76	.185			
	2050	.118	40.19	.184				
	Gain	320	.021	14.57		15.6%	17.8%	36.2%
Nov. 21, '05	1 lb 200 lb Ladle	2178	.128	46.34	.188			
	2000	.119	39.60	.182				
	Gain	178	.009	6.74		8.9%	7.5%	17%

Fig. 3 shows the remarkable effect in reducing chill in foundry iron by adding thereto powdered 50 per cent ferrosilicon in different proportions in the ladle, ranging from three to eight-tenths of 1 per cent of silicon.*

No. 1 shows the fracture of two test bars cast from a ladle of untreated iron. The upper piece was cast in green sand, 1 in. x 1 in. x 15-in., and was an ordinary transverse test bar. The lower piece was cast in a heavy iron cup in order to very rapidly cool the metal. The upper test piece is perfectly gray and easy to drill. The lower one is perfectly white and cannot be drilled with an ordinary steel drill.

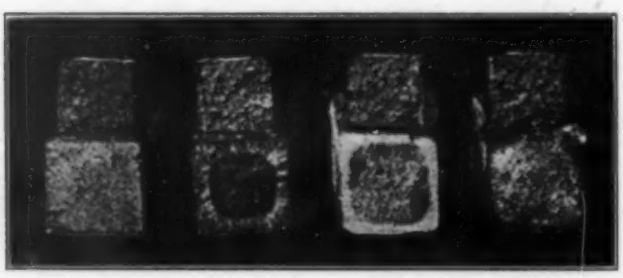
No. 2 shows the fracture of two similar test bars poured from the same iron after addition of 0.3 per cent of silicon in the form of high-grade ferrosilicon (50 per cent silicon) added in the ladle. Note the marked reduction in depth of chill in the sample cast in the iron cup.

No. 3 shows the fracture of two similar test pieces from the same iron after adding 0.5 per cent silicon in the ladle. The "chill" is still further reduced.

No. 4 shows the fracture of two similar bars from the same iron after adding 0.8 per cent silicon in the same manner. The chill in the sample cast in the iron cup is almost entirely absent.

The samples cast in sand are all perfectly gray, but there is an appreciable difference in the fracture, the treated metal showing softer iron than the untreated sample.

The metal selected for this particular test was comparatively low in silicon, consequently having com-



1 2 3 4

FIG. 3.—EFFECT OF ADDING POWDERED FERROSILICON TO LADLE.

*"Iron absorbs silicon greedily, uniting with it in all proportions at least up to 30 per cent and apparently the more readily the higher the temperature, absorbing it even at a red heat when imbedded in sand and charcoal. It diminishes the power of iron to combine with carbon * * * thus favoring the formation of graphite during slow cooling. It increases the fusibility and fluidity of iron; it lessens the formation of blow holes; by reducing iron oxide it apparently removes one cause of red shortness; it hinders at high temperatures the oxidation of iron and probably of the elements combined with it."—The Metallurgy of Steel by Henry M. Howe.

paratively high chilling property, but this fact would never be suspected from an examination of the fracture of the test sample cast in sand. Very few practical founders are aware of the large variation in chilling property if their iron, sometimes of presumably similar grades, melted on different days, or even of the wide variations in different portions of one heat.

Here we have, I think, a practical solution of one great difficulty that has heretofore militated against the successful use of permanent iron molds for making castings that must be machined.

A mere "skin chill" not thicker than a piece of tissue paper makes the surface of a casting too hard to machine, but by this simple process the foundry foreman can eliminate the last trace of chill from his metal before pouring it into an iron mold.

For years past more or less encouraging efforts have been made and described in technical journals of methods for making castings in permanent iron molds.

The most ambitious one, perhaps, was the pipe casting process of Mr. Custer at Tacony, a few years ago, for which he obtained several patents. Mr. Custer ingeniously overcame the trouble from skin chill on his castings by turning them out of the molds before the molecules had taken a final set and the intense heat in the body of the casting helped to anneal out any skin chill that might have formed. Mr. Custer failed, unfortunately, to take into due consideration the fact that gray cast iron, of which his molds were made, "grows" or increases in cubical dimensions when repeatedly heated above a certain point and then cooled. This, I am informed, causes such a rapid deterioration of his casting machines that his process proved a failure and has been discontinued.

It will, no doubt, be a great surprise to you to learn that ever since the year 1888 machinable castings have been made in the foundry of Wm. Sellers & Co., Inc., in permanent iron molds and still are being so made. I am, through the courtesy of the president of that company, now permitted to show photographs made for this address of original iron molds, still in use, together with some machinable castings that were made in them years ago. Also large and small molds of more recent manufacture. In fact, more than a hundred permanent iron molds, ranging in weight from a few pounds up to 7000 lb. each, are to be found in use in this foundry.

The main object of casting in iron molds is to secure machinable castings of exceedingly fine grain, free from dirt, sponginess or other defects, while at the same time having marked increase in strength.

The question of relative cost of castings made in permanent iron molds (eliminating the molder entirely), as compared with similar castings made in green sand or in baked sand molds, depends upon the number of machinable castings required to be made from one pattern as well as upon other conditions.

In Fig. 4 is shown a picture of an all-iron mold made in 1903 for a saddle for 36-in. planing machine, also one of the gray iron machinable castings, absolutely free from any skin chill, made in this mold.

This was a difficult casting to obtain free from surface defects on one or the other face, or from draw holes, when made in sand, but when cast in this iron mold they were perfect, and all the saddles subsequently made, until a change was made in design, were cast in this iron mold.

This mold was made fifteen years after my first iron mold for machinable castings was made and used in the foundry of Wm. Sellers & Co., and twenty-three years after the first iron mold was made by me for casting "over-iron" in another foundry, and thereby hangs an amusing tale.

In the year 1880, I suggested to the foreman of the car wheel foundry of A. Whitney & Sons, Philadelphia, with which I had become connected as metallurgist, the idea of casting all the "over-iron" in iron molds instead of in open sand molds, thus giving more room on the foundry floor and avoiding expense of making up a sand pig bed daily.

The foreman exclaimed in alarm, "Why it will be all white iron and when we remelt it with the wheel mixture the next day the wheels will all be too hard. We do use a little white iron sometimes to bring up the chill when the mixture is running down in chill, but this plan would spoil all our calculations."

Nothing but an actual demonstration would convince the man of his error.

Iron pig molds were then ordered to be made and a ton of regular wheel iron cast therein. This iron was, of course, white. On the next day the ton of white iron was remelted in a small cupola without any admixture and cast into test bars, chill test pieces and two test wheels. On the following day, when all of these were broken, instead of being white iron, as the foreman had predicted, there was no appreciable difference found between the castings made from iron that had been chilled white in the iron molds and similar castings made from the same iron cast in sand molds. The result was that no sand pig bed was ever again made in that foundry as long as the works existed.

On coming to the establishment of Wm. Sellers & Co., Inc., in March, 1888, I found the same conditions and immediately substituted iron pig molds, which have been used daily ever since that time.

These iron molds for over-iron anticipated the machine-cast pig iron process now so generally used by many years and naturally led to the next step, namely, making permanent iron molds for castings, as soon as it was found practicable to prevent iron poured in

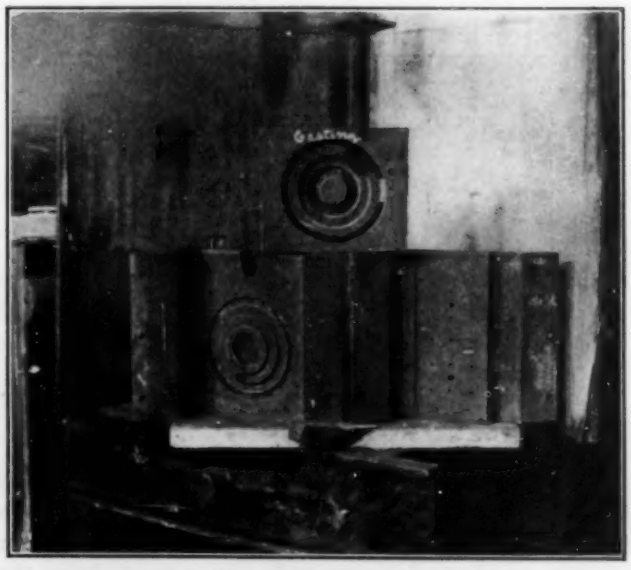


FIG. 4—IRON MOLD FOR SADDLE AND CASTING MADE IN THIS MOLD

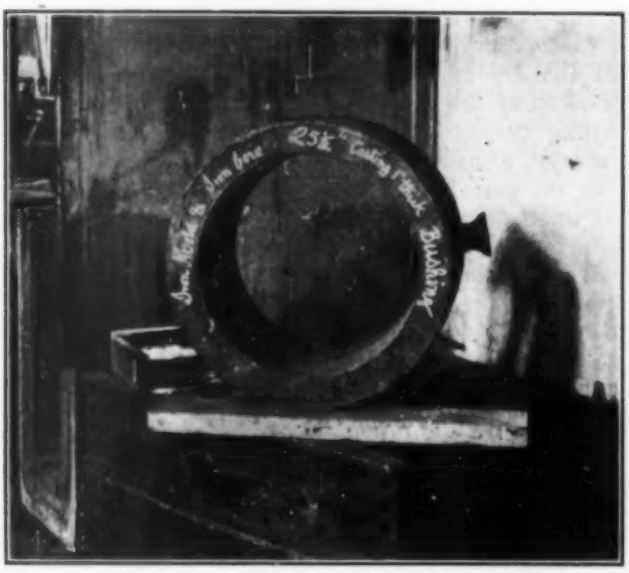


FIG. 5—IRON MOLD FOR LATHE BUSHING

FIG. 7—IRON MOLD AND CORE FOR SPIRAL PINION

them from being too hard to machine without trouble.

Fig. 4 shows an iron mold for "saddle" for 36-in. planing machine and casting made in this mold. The mold was made in 1903. This casting was a difficult one to make in a sand mold so as to get clean surfaces on both sides and free from draw holes. Fig. 5 shows an iron mold for bushing for 42-in. car-wheel lathe. This bushing is 19 in. in diameter, 13½ in. deep and only 1-in. thick. The mold is 6½-in. thick, and there is a collapsible iron core. The metal must be absolutely free from chill as the thin casting is turned inside and outside. Fig. 6 shows an iron mold for friction disks for dynamometer for Pennsylvania Railroad, 42 in. in diameter, cast 1½ in. thick, finished all over ⅞ in. thick. The pull on the draw bar of the locomotive on this machine was originally 80,000 lb., afterward increased to 100,000 lb. It was essential that these cast-iron disks should be fine grained and free from the slightest defects. After failing to procure satisfactory castings in sand molds they were cast in this iron mold and were perfect disks. The casting is poured from bottom. Fig. 7 shows an iron mold and iron core for

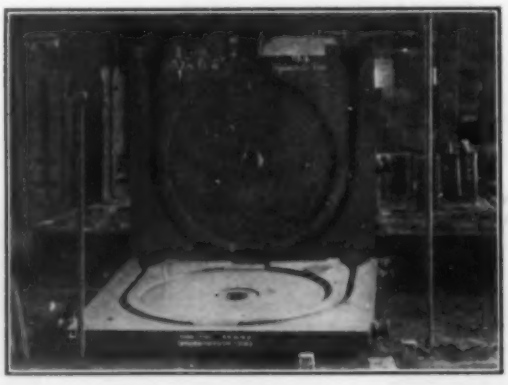


FIG. 6—IRON MOLD FOR FRICTION DISKS

spiral pinion for 36-in. planing machine. Five teeth 2 in. deep are cut from solid metal. "Semi-steel" is cast in this mold, free from chill, and poured from the bottom. Fig. 8 shows an iron mold for "over-pig." The molds were first made in 1880, and this mold has been in constant daily use for many years. On top of mold are two iron molds for "lifting nuts" from cross-head of large boring mills from 10 to 16 ft. These castings must be made of very strong, fine grained iron. Also on top are two test bars originally of the same size, viz., 14 13/16-in. x 1-in. x 1-in. cast in the same mold from one ladle of iron. One bar has been caused to "grow" or increase in size to 16½-in. x 1⅛-in. x 1⅛-in., equivalent to 40 98/100 per cent enlargement.

Anticipating the question, "How do you prevent these molds from warping or growing so as to become useless?" I will say there are two distinct methods. The simplest method and the one we adopt is to make but one casting from one melt in one iron mold. In this way the mold never gets red hot so that it does not grow. The second method is to use low silicon iron for the molds, as metal of that character grows far less when repeatedly heated and cooled above a cherry red

FIG. 8—IRON MOLD FOR OVER-PIG

than does soft foundry iron. Finally, I may say that castings made of white iron do not expand permanently when heated and cooled sufficiently to overcome the original shrinkage of the metal, so that when practicable, permanent iron molds may be made of white iron.

Cutting Oils

Their Properties, Composition, Examination and Industrial Application

By C. W. Copeland

Chief Chemist Remington Arms Company of Delaware..

The industrial chemist is frequently called upon to make an examination of compounded oils which, for want of a better name, are known as cutting oils. While these oils are not exactly new, the literature pertaining to them is rather vague and indefinite. In fact there seems to be a decided lack of literature on the subject and in view of the great importance of these oils to the modern metal cutting industries and considering the large sums expended annually for them, the subject is undoubtedly worthy of the fullest investigation.

It is the writer's intention, in the present article, to give a general résumé of the composition, properties and industrial use of these compounded oils, coupled with concise directions for examining them, so that the chemist may thereby form an intelligent opinion of their worth. In this manner, by making a preliminary examination of such oils in the laboratory, the chemist can eliminate much worthless and unsuitable material and greatly assist a plant engineer or the purchasing department in deciding upon the oils best fitted for each particular purpose. Furthermore, all oils that are found to be especially effective for each specific purpose can be kept up to the same standard by frequent analysis; specifications can be devised and adhered to, and much time, annoyance and expense can be saved, instead of proceeding with time-consuming and frequently haphazard shop testing of oils purchased at random.

The usual physical tests, as applied to lubricating and other purely mineral oils, are not of much service in examining oils of this character, nor are the standard methods for determining the chemical constants of animal and vegetable oils and fats applicable, but rather a combination of both.

The literature pertaining to mineral oils and their derivatives and to other oils, fats and waxes is extensive, and, as it is not within the scope of this article to treat of these in detail, the reader is referred to standard works on the subject for more complete information.

As compounded oils, however, are composed of these two widely different classes of oils, a brief description of their general characteristics follows:

Commercial mineral oils are derived from the different fractional distillations of crude petroleum. They are simple hydrocarbon oils which do not contain any organic fatty acids and are therefore not affected by any of the ordinary saponification agents. They are not true definite compounds in a chemical sense, their composition depending entirely upon their source and the temperature at which each fraction is distilled.

Animal and vegetable oils, on the other hand, exhibit certain well defined chemical characteristics which are uniform, within certain limits, for each particular oil. Olive oil, for instance, has certain chemical constants which vary but little, no matter how widely separated are the sources from which it is derived, and this is especially true of pure oil, consequently its purity and composition can be definitely ascertained by chemical means.

These oils are rather complex substances formed from glycerol and organic fatty acids, technically known as triglycerides, and natural oils and fats are mixed triglycerides containing one or more different fatty acids. All triglycerides are broken up and decomposed by heating them with caustic alkalies, undergoing saponification or hydrolysis with the formation of the alkaline salts of the fatty acids, and glycerol. These alkaline salts are commonly known as soaps and it is due to this phenomenon that analysis and separations of mixed mineral, animal and vegetable oils can be made, by varying the menstruum in which they are soluble and by various other means.

In the following treatment of the subject an attempt has been made to present it mainly from a chemical viewpoint, the details of application being left to the more experienced shop engineers.

Numerous examples of analyses are given to assist the chemist in interpreting his results.

The writer begs indulgence for this verbose introduction and hopes to provoke a discussion of this highly important subject which has been very much neglected.

STRAIGHT CUTTING OILS

For the metal cutting and stamping industries, certain simple and compounded oils are required and the function of these so-called cutting oils is to furnish lubrication to the point or surface of the cutting tool and also to conduct away the large amount of heat generated, so that the tool will not become overheated and the temper drawn. Of course, with the modern high-speed tool steels, this heating of the tool itself has not the serious effects as on a plain carbon tool steel, but as cutting oils in general greatly improve the quality of the work, making smoother and speedier cuts and at the same time greatly prolonging the life of the tool; they are almost universally used in drilling, boring, reaming, milling and various other operations.

A great variety of oils and cutting compounds are manufactured and used for this purpose and they may be roughly subdivided into two general classes, *straight* cutting oils and *soluble* cutting oils.

The straight cutting oils are used directly on the machines without any further treatment and are intended mainly for the more delicate lathe work and fine boring and reaming operations and also for operations on high-carbon, special-alloy steels and other metals, in cases where the hardness or other physical properties of these metals require special treatment.

These oils consist of either lard oil, sperm oil, or vegetable oils or a mixture of one or more of these oils with certain mineral oils. Pure lard oil or a mixture of lard and mineral oil are the most extensively used members of this class. Pure mineral oil can also be used as a straight cutting oil but only to a limited extent.

Pure lard oil is pre-eminently the ideal straight cutting oil for all classes of work excepting that in which the amount of heat generated by the cut is high, thus making the cooling action of the lubricant very important. It seems to have the property of adhering tenaciously to the point or surface of the cutting tool even under the influence of moderate heat, a property that is not possessed by many other oils having a much higher viscosity. Under certain conditions and for special

purposes, where other simple and compounded oils fail, lard oil will generally prove effective.

Lard oil to be efficient, however, should be of the best quality, as the poorer grades contain considerable amounts of free fatty acids which tend to cause corrosion of brass, copper and other metals and to damage the bearings and other parts of the machines. An excessive amount of free fatty acid will also cause the oil to be foul smelling and will gum the machines.

The extensive use of lard oil as a cutting medium is limited, however, due mainly to its high cost, which is over one dollar per gallon at present* although it has been as low as 60 cents per gallon. This high cost has led to the introduction and substitution of mixtures of lard oil with petroleum oils and to the limited application of mineral and other inexpensive oils on certain classes of work where such substitutes would give satisfactory results.

These oils are now extensively manufactured and are known as mineralized lard oil, lardoleum and by various other trade names.

For straight cutting work, an oil must possess a moderately high viscosity, excellent heat conductivity, a high flash and fire test and a fairly low cold test. It should be free running, non-corrosive and must not thicken or gum in use. It should be compounded from good neutral mineral oils, possessing in general the qualifications of lard oil, and a good grade of lard oil containing a minimum of free fatty acid, not over 5 per cent at the most. The compounded oil should be a homogeneous mixture that must not segregate into its various components upon standing. Rancid oils should not be considered in an oil of this character, especially when masked by phenolic or other disinfectants, on account of the injurious effects it would have on the hands and persons of the workmen.

As a general rule the efficiency of these oils is governed by the amount of lard oil they contain, and the price is usually fixed by the same factor.

As lard oils and vegetable oils are saponifiable oils, and as mineral oils are non-saponifiable oils, it is evident that if a compounded oil be made from pure materials we have a ready means of evaluating them by simply determining the amount of saponifiable matter they contain. Also a determination of the acidity of the oil, coupled with the usual physical oil tests, would give a further indication of its value. Oils made from inferior materials can be separated by saponification processes and the inferior oils can then generally be positively identified.

Adulteration and substitution of the more expensive oils is sometimes practiced in the manufacture of cutting oils. For instance, lard oil is sometimes adulterated with cottonseed, rosin and various other oils. While cutting oils compounded from these various oils would be perfectly satisfactory for certain purposes, the purchaser does not wish to pay high prices for them expecting to get lard oil; consequently their detection becomes an important matter.

SOLUBLE CUTTING OILS

The soluble cutting oils are divided into many classes, but all depend upon the property of forming a milky emulsion when mixed with water. These oils are made and used primarily for heat conduction in heavy cutting, drilling, milling, stamping and other operations and at the same time they furnish considerable lubrication at the cutting points and surfaces. A saturated water solution of sal-soda was originally employed for this cooling purpose, but as it was devoid of lubricating properties, it has been largely replaced by soluble oil compounds.

These oils are usually compounded from mineral oils mixed with a specially treated animal or vegetable oil such as lard, cottonseed, corn, rapeseed, castor, olive rosin, neatsfoot and various other oils. They are known as sulphonated, phenolated and soap oils.

The *sulphonated oils* are made by treating castor oil with concentrated sulphuric acid, thereby forming a sulpho-compound with the ricinoleic acid of the oil. This treatment with sulphuric acid is proceeded with until a portion of the oil is found to be soluble in water. The mixture is then treated with common salt and the excess of acid is then neutralized with ammonia or other alkali. This base is then mixed with the proper proportion of mineral oil, sufficient care being taken to add enough of the base to hold all of the oil in an emulsion when the water is added. Turkey-red oil is an example of this class of oils and while castor oil is generally used, forming a true sulpho-compound, other oils such as cottonseed, olive, etc., may be substituted. These oils usually have an acid reaction toward phenolphthalein, and unless care is used in their manufacture they are liable to cause trouble by containing free sulphuric acid which would cause serious corrosion.

Soap oils (soluble oils containing soap) are compounded from mineral oils and a saponifiable oil, either animal or vegetable. Part or all of the animal or vegetable oil is saponified with an alkali, forming a soap, and the product is then added to the mineral oil in the proper proportions so that when it is diluted with water a creamy emulsion is formed, the soap acting as a carrier for the mineral oil and the unsaponified fat, holding these oils in suspension in the water. The free fatty acids, usually oleic or resin acids, are generally used for making the soap, being cheaper; this is then mixed with the neutral oil, the mineral oil and the other ingredients. Alcohol is sometimes added to effect a more ready solution of the soap and to keep the compounded oil clear. In this class of oils an excessive amount of soap should be avoided or gumming is liable to result. Amounts up to 15 per cent are permissible, but if they are properly manufactured less than 10 per cent seems to be quite sufficient.

The *phenolated oils* are similar to the soap oils in composition, being compounded from carbolic acid and an alkali. The phenolic odor of such oils suggests a disinfectant and is sometimes used to mask the odor of rancid fats. However, if these oils are properly made, this odor is not objectionable and is not detrimental.

Most of the soluble oils are of the above general classes and are manufactured under various trade names, the details of manufacture generally being kept secret by the makers. The subsequent analyses, made of various kinds of these soluble oils, will give an excellent idea of their general composition.

A first-class soluble oil should be a homogeneous mixture that should not segregate into its various components upon standing; it should form a perfect emulsion with water with the minimum separation of mineral oil. To give the best results soluble oils should be carefully

*When this was written (6-24-17) prime lard oil was $1.80 per gal.

made from high-grade materials, otherwise they are likely to cause trouble by rusting the machines and work, being corrosive and gumming the slides and other moving parts of the machines.

With soluble oils no hard and fast rules can be laid down for their evaluation. The total saponifiable matter, the percentage of free fatty acids, the neutral oil as fat and the amount of soap present are important considerations. Of decided importance is the stability of the emulsion formed with water at the various dilutions, as separation of the oil and water may cause damage to the tools, work or machines, besides losing the lubricating value of the compound. The amount of water and volatile matter present should also be considered, likewise any propensity toward gumming. The usual physical tests are not of much service in examining these oils, as they are never used in their original condition.

The intelligence and skill used in the manufacture of these oils is an important factor, as some oils containing a minimum amount of saponifiable matter, soap, etc., may be perfectly satisfactory, while conversely, an oil showing a relatively high percentage of these same constituents may be worthless, due to the lack of knowledge on the part of the manufacturer. As with straight cutting oils, no oil of this character should be considered that has been compounded from rancid and inferior animal or vegetable fats, the odor of which is usually masked by phenolic or other disinfectants.

Regarding the actual application of the various kinds of cutting oils and compounds, their use should be governed entirely by the conditions and the kind of work which they may be called upon to perform, and the treatment herein given, applying to this branch, has been more or less of a general nature.

For detailed information regarding the application, distribution, costs and other data concerning these oils, the reader is referred to a most complete and excellent article by Edward K. Hammond.[1]

Methods of Analysis

Two general methods were devised for the analysis of compounded oils, designated as A and B. Method A is a gravimetric separation of the saponifiable matter and the mineral oil and is useful as a check method and also where a further examination of the separated oils is contemplated, to determine their origin, nature and characteristics. Method B is a volumetric method and gives more complete information as to the condition of the saponifiable matter; it is also much more rapid. Both methods can be applied to the two classes of oils without any changes.

In the following methods, all flasks and other containers used for weighing samples and residues should be first thoroughly cleaned, rinsed with distilled water, alcohol, ether and then dried in an oven for one hour at a temperature of 100 deg. to 105 deg. C.

Preparation of Sample.—Mix the oil thoroughly by vigorously shaking the container, or, if in a barrel, by rolling it on the bilge; then fill two 4-ounce oil sample bottles with the well-mixed oil and label properly. Use one sample for the general analysis and place the other sample where it will not be disturbed for use later in the segregation test.

[1] *Machinery*, January, 1917.

Before commencing the analysis, the color, odor, turbidity and any other characteristics of the original oil should be noted.

Method A—Determination of Saponifiable Oil and Mineral Oil

Weigh 4 to 6 grams of the thoroughly mixed oil in a 300-cc Erlenmeyer flask, add 50 cc of the alcoholic potash (40 grams of potassium hydroxide dissolved in one liter of alcohol that has been redistilled after standing for some time over potassium hydroxide), and then boil the mixture under a reflux condenser for from one to two hours. An oil or water bath maintained at about 100° C., or an electric hot plate is suitable for boiling the liquid.

Disconnect the apparatus and boil off most of the alcohol, being careful not to overheat the oil or decomposition may result. Add about 50 cc of hot water to the residue in the flask, agitate and transfer to a 500-cc separatory funnel and wash out the contents of the flask with small successive portions of hot water, keeping the total volume in the funnel under 150 c.c. Cool the solution in running water and when cold add 75 cc of ether, stopper the funnel and shake vigorously. Allow the two layers to separate for about 12 hours or over night. If, after standing for some time, the solution does not show a tendency to separate into two distinct layers, the separation may be accelerated by adding a little alcohol, about 2 cc at a time, and shaking after each addition, which will usually effect a complete separation. The upper layer contains the ethereal solution of the unaffected mineral oil and the lower layer contains the animal or vegetable oil which has been converted into water soluble soap by saponification with the alcoholic potash.

Run the lower layer into another separatory funnel and wash the ethereal solution with about 50 cc of cold water, allowing the water to run down the sides of the funnel while rotating the same; allow to clear and then run the wash water into the second funnel. Add dilute sulphuric acid, containing about 5 cc of concentrated acid, to the soap solution in the second funnel to liberate the fatty acids. Cool in running water and when cold add 75 cc of ether, stopper the funnel and shake vigorously, allow to separate for about one-half hour or until clear and then run off the lower aqueous layer which is discarded.

Wash the ethereal solution of the fatty acids with about 50 cc. of cold water, allowing the water to run down the sides of the funnel while rotating the same; allow to clear, run off and repeat the washing with cold water until the wash water is no longer acid to blue litmus paper; about two washings will suffice.

Saponifiable Oil.—Drain off the wash water entirely from the ether solution of the fatty acids and then run the ethereal solution into a weighed 150-c.c. Erlenmeyer flask and rinse out the funnel with a small amount of ether. Cautiously evaporate off the ether and then heat the flask for one hour in a drying oven at a temperature of 100 to 105 deg. C., cool and weigh as saponifiable matter. The saponifiable matter in this case consists of the hydrates of the fatty acids. If any water is carried over into the ether solution, it may be removed when heating the residue, by spreading the oil in a thin layer over the interior of the flask; any water

present is then more easily volatilized without causing the oil to spurt.

Mineral Oil.—Drain off the wash water entirely from the ethereal solution of the mineral oil in the first funnel and then run the ethereal solution into a weighed 150-c.c. Erlenmeyer flask and rinse out the funnel with a small amount of ether. Proceed with the evaporation, heating, etc., exactly as directed for the determination of the saponifiable oil, finally weighing the product as mineral oil.

Method B—Determination of Total Saponifiable Matter and Total Fatty Acids

Weigh 4 to 6 grams of the oil in a 300-c.c. Erlenmeyer flask, add 50 c.c. of the alcoholic potash solution and boil the mixture under a reflux condenser for from one to two hours. Disconnect the apparatus, boil off most of the alcohol, add about 50 c.c. of hot water to the residue, agitate and transfer to a 500-c.c. separatory funnel and wash out the flask with small successive portions of hot water. Add dilute sulphuric acid, containing about 5 c.c. of concentrated acid, to the solution in the funnel and cool in running water; when cold add 75 c.c. of ether, stopper and shake vigorously. Allow the two layers to separate for about one-half hour or longer if necessary; when clear, run off the lower aqueous layer and discard. Wash the ethereal solution with about 50 c.c. of cold water, allowing the water to run down the sides of the funnel while rotating the same, being careful not to disturb the ethereal layer too much, as troublesome emulsions are liable to be formed. Allow to stand until clear, run off the wash water, discard and repeat the washing with cold water until the wash water is free from acid when tested with blue litmus paper, about two washings will suffice. Drain the ethereal solution into the original flask, which has been rinsed with a little alcohol and allowed to drain, and wash out the funnel with a small amount of ether. Cautiously evaporate the solution in the flask until most of the ether has been driven off.

Neutralize 50 c.c. of alcohol with tenth-normal alkali, using 20 drops of a 1 per cent solution of phenolphthalein as an indicator. Add the neutral alcohol to the contents of the flask, heat to boiling and titrate with the tenth-normal alkali until the pink color persists after vigorous shaking. The flask should be stoppered and shaken vigorously toward the end of the titration.

Total Saponifiable Matter.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.028773 and divide by the weight of the sample taken, to obtain the total saponifiable matter in one gram of the oil.

In this titration it is assumed that one gram of the saponifiable matter requires 195 milligrams of potassium hydroxide for its saturation, i.e. it has a saponification value of 195. One cubic centimeter of tenth-normal alkali is equivalent to 0.0056108 grams of potassium hydroxide, consequently

$$\frac{0.0056108}{0.195} = 0.028773.$$

This factor is accurate for most of the oils entering into this class of compounds; exceptions will be noted later.

Total Fatty Acids.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.0282 and divide by the weight of the sample taken, to obtain the total fatty acids in one gram of the oil.

The above factor is based on the assumption that the fatty acids exist as oleic or some similar acid, which is a very close approximation of the truth; exceptions will be noted later.

DETERMINATION OF FREE FATTY ACIDS

Weigh 5 to 10 grams of the oil in a 300-c.c. Erlenmeyer flask. Neutralize 50 c.c. of alcohol with tenth-normal alkali, using 20 drops of phenolphthalein as an indicator. Add the neutral alcohol to the contents of the flask, heat to boiling and titrate with the tenth-normal alkali until the pink color persists after vigorous shaking. The flask should be stoppered and vigorously shaken toward the end of the titration.

Free Fatty Acids.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.0282 and divide by the weight of the sample taken, to obtain the free fatty acids, as oleic acid, in one gram of the oil.

DETERMINATION OF SOAP, FATTY ACIDS COMBINED AS SOAP, FATTY ACIDS COMBINED AS FAT AND NEUTRAL OIL

Weigh 4 to 6 grams of the oil in a 300-c.c. Erlenmeyer flask, add about 50 c.c. of hot water, agitate, transfer to a 500-c.c. separatory funnel and wash out the flask with small successive portions of hot water. Add dilute sulphuric acid, containing about 5 c.c. of concentrated acid, to the solution in the funnel and cool in running water. When cold, add 75 c.c. of ether, stopper the funnel and shake vigorously. Allow the two layers to separate for about one-half hour or longer if necessary; when clear, run off the lower aqueous layer and discard. Wash the ethereal layer with about 50 c.c. of cold water, allowing the water to run down the sides of the funnel while rotating the same. Allow to stand until clear, run off the wash water and repeat the washing with cold water until the wash water is no longer acid when tested with blue litmus paper; about two washings will suffice. Run the ethereal solution into the original flask, which has been previously rinsed with a little alcohol and allowed to drain and carefully evaporate off most of the ether.

Neutralize 50 c.c. of alcohol with tenth-normal alkali, using 20 drops of phenolphthalein as an indicator. Add the neutral alcohol to the contents of the flask, heat to boiling and titrate with the tenth-normal alkali until the pink color persists after vigorous shaking of the stoppered flask.

Fatty Acids as Soap.—Multiply the number of cubic centimeters of tenth-normal alkali used in this titration by 0.0282 and divide by the weight of the sample taken and call the result (*a*). Subtract from this result the free fatty acids, per gram of oil, as found in a previous determination, and the remainder is the fatty acids combined as soap in one gram of the oil.

Soap.—Multiply the result obtained for the fatty acids combined as soap by 1.078; the product is the sodium soap formed by the alkali and these acids.

Sodium soap (sodium oleate), mol. weight.

$$\frac{304}{282} = 1.078.$$

Fatty acids (oleic acid), mol. weight

$$\frac{304}{282} = 1.078.$$

If a potassium soap is required, substitute the factor 1.13 in the above calculation.

Fatty Acids as Fat.—Subtract the result (*a*) from the total fatty acids found in a previous determination, to obtain the fatty acids combined as fat in 1 gram of the oil.

Neutral Fatty Oil.—Subtract the result (*a*) from the total saponifiable matter found in a previous determination, to obtain the neutral fatty oil in 1 gram of the sample.

NOTES

All of the determinations in the foregoing methods of analysis are applicable and useful in the examination of soluble cutting oils, but as straight cutting oils obviously do not contain soap nor fatty acids as soap, these determinations are omitted. There are actually only three determinations in method B, the other information being obtained by simple calculations. Much time can be saved if the titrations are all performed at one time and several oils can be analyzed successively, leaving the titrations to the last. The end point in these titrations is usually very sharp, but if any trouble is experienced in accurately determining this point with dark-colored oils, by titrating back with tenth-normal hydrochloric acid, the change can be rendered very distinct so that one or two drops of either standard solution will give the color reaction. It is advisable to follow this procedure in all of the titrations, as very concordant results can then be obtained and over-titrations avoided.

As method A gravimetrically determines only the hydrates of the fatty acids that exist in the oil, the results by this method will be a trifle low for oils where these fatty acids were originally present as neutral fatty oil, due to the loss of the glycerol radicle. This loss is somewhat compensated for, due to the fact that the fatty acids are weighed as hydrates and not as anhydrides.

In method B the total saponifiable matter is based on the assumption that the oil has a saponification value of 195, which is correct for most of the oils entering into this class of compounds. Sulphonated oils, however, usually contain a castor oil base which has a saponification value of about 184, consequently

$$\frac{0.0056108}{0.184} = 0.0305.$$

This factor would be the proper one to use when castor oil is required and 0.02983 would be the correct factor for the ricinoleic acid of this oil.

PHYSICAL TESTS

Emulsification Test.—Prepare an emulsion of the soluble oil by mixing a measured portion of the oil with the required amount of water, place in a 4-ounce oil sample bottle and set aside for further observation. One part of oil to ten or twenty parts of water is sufficient for test purposes, but any other required volume of water may be used. The character of the emulsion should be noted while preparing the same and again examined after standing undisturbed for 24 hours.

Segregation Test.—After standing for at least 24 hours, weigh out a portion of the oil which was placed aside for the segregation test, by pouring from the upper surface without disturbing the rest of the oil. Make a determination of the free fatty acids or the total saponifiable matter on this sample. Any difference in this determination from the one made with the well-mixed sample is proof of the segregation of the oil into its various components; this segregation increasing, of course, the longer the oil is allowed to stand undisturbed until it reaches a maximum.

Evaporation Test.—Weigh 1 to 2 grams of the oil in a weighed Petri dish or in a shallow flat aluminium dish about 50 to 75 mm. in diameter. Place in a drying oven and heat at a temperature of 100 to 105 deg. C. for about 3 hours, cool and weigh. Replace in the oven for 30 minutes, cool, weigh and repeat the operation until a fairly constant weight is obtained. The loss in weight divided by the weight of the sample taken is the water, alcohol and any other volatile matter in 1 gram of the oil. The residue should then be examined to see if it shows any tendency toward gumming.

Compounded oils that contain light mineral oils will require heating over long periods, as considerable portions of this light oil will volatilize at this temperature.

To determine the amount of volatile mineral oil, first ascertain the temperature at which the oil will flash when it is heated in an open cup tester and then proceed as follows: Weigh out a portion of the mineral oil, which has been separated by method A, into the evaporating dish, as directed above. There seems to be very little loss of mineral oil when it is dried in the flask as directed in method A, which is probably due to the shape of the flask.

Place the dish containing the oil in the drying oven and heat at a few degrees below the flashing temperature until the weight is fairly constant. The loss in weight divided by the weight of the oil taken will give the amount of mineral oil volatile at this temperature, and this result divided by the percentage of total mineral oil will give the percentage of volatile mineral oil.

Physical Oil Tests.—The usual physical oil tests are too well known to require more than a brief mention here.

Determine the specific gravity with a Westphal balance or with an accurately calibrated hydrometer. The hydrometer is usually used and is much more rapid.

Determine the flash and fire test in an open cup tester of the Cleveland type.

The viscosity should be determined at 100 deg. Fahr. with a Saybolt viscosimeter. If the oil is too viscous to determine its viscosity at this temperature, a higher temperature may be employed. Most cutting oils, however, will move freely at 100 deg. Fahr., and as the results are only comparative this or some other uniform temperature should always be employed.

For the cold and cloud tests, any standard or suitably assembled apparatus may be used, the temperature being varied, of course, to suit the requirements of the oil being tested.

The above tests apply mainly to straight cutting oils.

Analyses of Soluble Cutting Oils

Following is an analysis of a soluble cutting oil and the results shown demonstrate the agreement and uni-

Oil No. 1

Test No.	Total saponifiable matter	Total fatty acids	Free fatty acids	Fatty acids as fat	Fatty acids as soap	Soap	Neutral fatty oil	Mineral oil
Method A—								
1	18.96	...	...	...	...	...	...	72.14
2	18.83	...	...	...	...	...	...	72.02
3	18.67	...	...	...	...	...	...	72.20
Average	18.82	...	...	...	...	...	...	72.12
Method B—								
1	18.81	18.44	6.25	0.98	11.21	12.12	1.35	...
2	18.71	18.34	6.21	0.98	11.15	12.05	1.35	...
3	18.65	18.28	6.13	0.98	11.17	12.07	1.35	...
Average	18.72	18.35	6.20	0.98	11.18	12.08	1.35	...

Water and volatile matter, 8.26 per cent.

formity that may ordinarily be expected in an analysis by the foregoing methods.

In its original condition this oil is a cloudy, reddish, viscous liquid, possessing a slight alcoholic odor and undergoing oxidation if left exposed to the air, a thick scum being formed on the surface. This oil is evidently a soap oil, as shown by the moderately large amount of soap present, and furthermore, that this oil was compounded from fatty acids is shown by the large amount of free fatty acid and the small amount of neutral fatty oil found; of the 18.72 per cent of total saponifiable matter, 17.38 per cent was present in the original oil as fatty acid and 1.35 per cent as neutral fatty oil. The fatty acid used was evidently oleic acid.

After standing for different periods the original oil showed a decided tendency to segregate, the total saponifiable matter varying from 6 to 20 per cent, the soap evidently precipitating and settling to the bottom of the container.

The 1 to 10 and 1 to 20 water emulsion, prepared with either warm or cold water and the well-mixed oil, is fair, emulsion is cream colored, foaming slightly when agitated; after 24 hours had a slight curd on the surface and a slight separation of mineral oil. The emulsion prepared from the oil after standing, without mixing thoroughly, is very poor, a large proportion of the mineral oil separating immediately.

This oil could not be recommended except in cases where a low price might prove a consideration, as its segregating and oxidizing properties would require special care and precaution in mixing. The price of this oil is about 50 cents per gallon, consequently the above objections would practically eliminate it, as much better oils can be obtained for the same price.

The general composition of this oil would be about as follows:

Mineral oil	72.12%
Free fatty acid	6.20%
Soap	12.08%
Neutral fatty oil	1.35%
Water and volatile matter	8.26%
Total	100.01%

Oil No. 2

	Method A	Method B	Castor Oil Base
Total saponifiable matter	12.86%	12.12%	12.92%
Total fatty acids	....	11.86%	12.56%
Free fatty acids	....	11.43%	12.08%
Fatty acids as fat	....	0.17%	0.21%
Fatty acids as soap	....	0.25%	....
Soap	....	0.28%	....
Neutral fatty oil	....	0.44%	0.62%
Mineral oil	77.57%	....	....
Total volatile matter			25.35%
Volatile mineral oil			18.30%
Water, ammonia, alcohol, etc.			7.05%

The above is an analysis of a soluble oil which was clear, wine-red and rather fluid in its original condition and possessed a strong odor of ammonia and kerosene or some similar volatile mineral oil. The presence of ammonia was shown by the vapor from the oil causing red litmus paper to turn blue. The original oil flashed at 150 deg. Fahr. and burned at 160 deg. Fahr. in an open cup tester, showing conclusively the presence of light mineral oils, kerosene or gasoline, which were present to the extent of 18.30 per cent, as shown by an evaporation test.

The reaction of the oil toward phenolphthalein was acid, notwithstanding the ammonia which was present which does not affect this indicator; this acid reaction was due to the organic acids present.

That this oil is evidently a sulphonated oil is shown by the absence of soap and by the large amount of free fatty acids present; the saponifiable matter in such an oil would be largely in the form of sulpho-acids.

This oil was analyzed by methods A and B; method A determines the total fatty acids gravimetrically; method B is evidently too low based on the assumption that the saponifiable matter is lard oil or some similar oil with a saponification value of 195. Sulphonated oils are usually made from castor oil which has a saponification value of about 184, consequently basing our calculations on this value and figuring the fatty acids as ricinoleic acid, we get the results as tabulated under castor oil base; the results for the total saponifiable matter by both methods then agree closely.

This oil showed but very slight tendency to segregate in its original condition and it does not oxidize or thicken on exposure to the air. The slight segregation consists in forcing more of the sulpho-base to the surface of the oil.

The 1 to 10 and 1 to 20 emulsions formed with cool water were excellent, foaming slightly in preparation; after standing for 24 hours showed a slight curd on the surface and a slight separation of mineral oil. Hot water should not be used, as it causes a decided separation of mineral oil.

The above oil can be recommended for excellent emulsification, freedom from oxidation, thickening, gumming; for non-segregation and freedom from mineral acids and other corrosive agents. The main objection is the presence of considerable volatile mineral oil, which would constitute a fire hazard if the oil be left exposed before using; this objection, however, does not apply to any great extent after the oil has been emulsified. The price is 48 cents per gallon.

The general composition of this oil would be about as follows:

Non-volatile mineral oil	59.27%
Volatile mineral oil	18.30%
Fatty sulpho-acids	15.34%
Neutral fatty oil	0.62%
Water, ammonia and other volatiles	7.05%
Total	100.58%

Oil No. 3

	Method A	Method B
Total saponifiable matter	15.30%	15.57%
Total fatty acids	....	15.25%
Free fatty acids	....	0.13%
Fatty acids as fat	....	5.47%
Fatty acids as soap	....	9.65%
Soap	....	10.40%
Neutral fatty oil	....	5.80%
Mineral oil	75.50%	....
Total saponifiable matter after standing (segregation)	....	8.58%
Total saponifiable matter of the well mixed oil (segregation)		15.57%
Water, alcohol, etc.		8.40%

The above is an analysis of a soluble oil which was a

clear, brown-red fluid oil in its original condition with a slight alcoholic phenol odor.

That this oil is evidently a soap oil is shown by the presence of considerable soap and that it was compounded from good neutral oils is shown by the trifling amount of free fatty acids present.

In its original condition this oil showed a decided tendency to segregate upon standing and this segregation consisted in the settling out of the soap, forcing the volatile matter and mineral oil to the surface.

The 1 to 10 and 1 to 20 emulsions formed with cool water were very poor, the mineral oil separating almost immediately; after standing for 24 hours there was a large separation of mineral oil. The same result was obtained by using warm water for the emulsion.

The above oil could not be recommended because of its segregation and for its poor emulsification qualities. The price is 48 cents per gallon.

This oil is an example of good materials being compounded into a poor soluble oil by lack of skill and knowledge on the part of the manufacturer; the defect in this case being possibly an insufficiency of soap to carry all of the particular mineral oil in suspension when it is diluted with water.

The general composition of this oil would be about as follows:

Mineral oil	75.50%
Neutral fatty oil	5.80%
Soap	10.40%
Free fatty acids	0.13%
Water, alcohol, etc.	8.40%
Total	100.23%

Oil No. 4

	Method A	Method B
Total saponifiable matter	17.06%	16.37%
Total fatty acids		16.05%
Free fatty acids		4.68%
Fatty acids as fat		3.71%
Fatty acids as soap		7.66%
Soap		8.26%
Neutral fatty oil		4.03%
Mineral oil	76.26%	

Water, alcohol, etc., 7.00%. Segregation, none.

The above is an analysis of a soluble oil which, in its original condition, is a clear, dark-red, fluid oil possessing a slight odor of alcohol and a deep blue bloom or fluorescence.

This oil is a soap oil which does not oxidize or thicken on exposure to the air; an evaporation test showed no gummy residue, and the oil does not segregate upon standing.

The 1 to 10 and 1 to 20 emulsions formed with warm or cold water were excellent white emulsions, foaming slightly in preparation; after 24 hours there was no separation of mineral oil and no formation of curd.

This oil could be highly recommended for its non-segregation, freedom from thickening, oxidizing, gumming and for perfect emulsifying qualities. The price is 45 cents per gallon.

This oil is an example of what would constitute a nearly perfect oil which has been compounded properly and at the same time containing only a moderate amount of soap and saponifiable matter.

The general composition of this oil would be represented by the following:

Mineral oil	76.26%
Neutral fatty oil	4.03%
Free fatty acids	4.68%
Soap	8.26%
Water, alcohol, etc.	7.00%
Total	100.23%

Oil No. 5

	Method A	Method B	Castor Oil Base
Total saponifiable matter	18.24%	17.21%	18.29%
Total fatty acids		16.86%	17.82%
Free fatty acids		14.80%	15.65%
Fatty acids as fat		1.62%	1.70%
Neutral fatty oil		1.97%	2.17%
Mineral oil	75.22%	....	....
Total volatile matter			17.37%
Volatile mineral oil (segregation very slight)			14.07%
Water, ammonia, etc.			3.30%

The above is an analysis of a soluble oil which, in its original condition, was a clear, wine-red, fluid oil possessing a strong odor of ammonia and a deep fluorescence or bloom. This oil contained considerable quantities of volatile mineral oils, the original oil flashing at 135 deg. Fahr. and burning at 145 deg. Fahr.

An inspection of the analysis shows this oil is a sulphonated oil and it possesses in general the characteristics of Oil No. 2 regarding segregation, emulsification, oxidation, thickening, gumming and freedom from corrosive acids.

It can be recommended, with reservations as to fire hazard, the same as the preceding oil. The price is 44 cents per gallon.

The general composition of this oil would be about as follows:

Non-volatile mineral oil	61.15%
Volatile mineral oil	14.07%
Fatty sulpho-acids	19.87%
Neutral fatty oil	2.17%
Water, ammonia, etc.	3.30%
Total	100.56%

Oil No. 6

	Method A	Method B
Total saponifiable matter	22.00%	21.71%
Total fatty acids		21.30%
Free fatty acids		5.08%
Fatty acids as fat		8.90%
Fatty acids as soap		7.32%
Soap		7.88%
Neutral fatty oil		9.31%
Mineral oil	67.25%	....

Water, alcohol, etc., 10.68%.
Free fatty acids after standing 24 hours, 4.28%

Free fatty acids of well mixed oil, 5.08% = 8.42% segregation.

The above is an analysis of a soluble oil which, in its original condition, is a clear, red, fluid oil possessing an alcoholic odor and a slight bloom.

The main defect in this oil is its segregation, which consists in the precipitation of soap and fatty matter, this material settling slowly to the bottom of the container.

Emulsion is good, very slight separation of curd and mineral oil.

This oil could be recommended as a good oil except for its segregation. The price is 45 cents per gallon. Its general composition follows:

Mineral oil	67.25%
Neutral fatty oil	9.31%
Free fatty acids	5.08%
Soap	7.88%
Water, alcohol, etc.	10.68%
Total	100.20%

Oil No. 7

	Method A	Method B
Total saponifiable matter	12.70%	12.80%
Total fatty acids		12.54%
Free fatty acids		4.23%
Fatty acids as fat		0.57%
Fatty acids as soap		7.74%
Soap		8.34%
Neutral fatty oil		0.53%
Mineral oil	79.08%	....

Water, alcohol, etc., 7.60%. Segregation, none.

The above is an analysis of a soluble oil which is a

clear, dark-red, fluid oil possessing an alcoholic odor and a deep blue bloom.

This oil is almost identical with Oil No. 4, excepting that it contains less saponifiable matter; it is made by a different manufacturer.

This oil can be recommended in every respect as a high-class oil. The price is 50 cents per gallon.

The general composition of this oil is about as follows:

Mineral oil	79.08%
Neutral fatty oil	0.83%
Free fatty acids	4.23%
Soap	8.36%
Water, alcohol, etc.	7.60%
Total	100.10%

Oil No. 8

Total saponifiable oil	24.87%
Mineral oil	74.72%
Total	99.59%
Free fatty acids	12.76%
Specific gravity at 60 deg. F.	0.892
Baumé at 60 deg. F.	26.9 deg.
Flash test	355.0 deg. F.
Fire test	390.0 deg. F.
Viscosity at 100 deg. F.	111.0 sec.

The above is an analysis of a straight cutting oil, a turbid, odorless, dark colored oil which contained precipitated fats, probably stearine or stearic acid, this precipitate settling to the bottom of the container upon standing.

This oil should be rejected for excessive free fatty acids and for low viscosity. The price is 45 cents per gallon.

Oil No. 9

Total saponifiable oil	32.20%
Mineral oil	67.60%
Total	99.80%
Free fatty acids	4.15%
Specific gravity at 60 deg. F.	0.889
Baumé at 60 deg. F.	27.5 deg.
Flash test	396.0 deg. F.
Fire test	440.0 deg. F.
Viscosity at 100 deg. F.	192.0 sec.

The above is an analysis of a straight cutting oil, a clear, dark-red oil, possessing a slight blue bloom and a lard oil odor. There is no segregation in this oil and the separated saponifiable oil is light-colored and free from objectionable odor.

This oil can be recommended for moderately low free fatty acid content, adequate viscosity, flash and fire test and for good general composition. It can be safely used on all such cutting work for which it would prove satisfactory.

The price is 60 cents per gallon.

Oil No. 10

Total saponifiable oil	11.60%
Mineral oil	88.00%
Total	99.60%
Free fatty acids	3.10%
Specific gravity at 60 deg. F.	0.900
Baumé at 60 deg. F.	25.4 deg.
Flash test	360.0 deg. F.
Fire test	410.0 deg. F.
Viscosity at 100 deg. F.	164.0 sec.

The above is an analysis of a straight cutting oil, a black-colored, opaque oil with a very disagreeable odor. Saponifiable oil has a rotten odor, suggesting Dippel animal oils.

This oil should be rejected for poor composition, being compounded from inferior animal oils.

Oil No. 11

Total saponifiable matter	18.88%
Mineral oil	81.00%
Total	99.88%
Free fatty acids	2.08%
Specific gravity at 60 deg. F.	0.883
Baumé at 60 deg. F.	28.5 deg.
Flash test	410.0 deg. F.
Fire test	455.0 deg. F.
Viscosity at 100 deg. F.	176.0 sec.

The above is an analysis of a straight cutting oil, a clear, reddish oil, possessing a slight blue bloom and a slight lard oil odor. Saponifiable oil is light colored, with an odor of lard oil. There is no segregation in this oil.

This oil can be recommended for purity of composition, low free fatty acid content, adequate viscosity, high flash and fire test and moderate price.

It can be safely used for all such cutting work, for which it will prove satisfactory. The price is 37 cents per gallon.

Remington Arms Company of Delaware.
Eddystone, Pa.

Industrial Wastes Disposal*

By Harrison P. Eddy

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While there are various waste materials resulting from the industries, the term "industrial wastes" has come to mean the liquid wastes from the processes employed in industrial establishments. In England they are called "trade wastes"—a term not quite as applicable in this country, although occasionally used. Neither the human excrement of operatives nor their wash waters are comprehended in this term, although in many cases there is no effort to prevent their admixture.

ORIGIN OF INDUSTRIAL WASTES.

Many industries employ great quantities of water for various purposes such as condensing, washing of raw stock, dilution of chemicals, transportation and application of materials and the washing and rinsing of finished products.

Some of these uses do not defile the water and it can be discharged at will, as for example many condenser waters. Other uses result in a very great change in the character of the water and render it unsuitable for discharge into some waterways.

In paper mills, after the digestion of the raw stock with strong chemicals, there remain the liquors, highly charged with mineral and organic substances, but for which the manufacturer has no further use. He therefore seeks to get rid of them in the most expeditious and least expensive manner. The fibrous stock is then washed and large quantities of wastes are discharged from the washers, more or less highly charged with substances like those already mentioned. From the paper machines come great quantities of water carrying fine fiber, clay, coloring matter and other substances depending upon the character of paper made and the processes employed.

In tanneries, pure water is indispensable, but after use it is highly colored, charged with spent chemicals and loaded with organic matter. Its burden of im-

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purity is partly in suspension and partly in solution. Wastes from different processes within the same tannery often react upon one another, throwing out of solution substances which in their new physical condition may be deposited in waterways to their detriment. Some tannery wastes of themselves are so resistant to bacterial action that they do not readily putrefy, yet when diluted with the waters of a natural stream they may become most offensive.

The wastes of woolen mills vary radically from those of paper mills and tanneries, yet they may be the cause of just as serious complaints. The grease and soaps from the scouring of the wool, the spent dye liquors, the soaps from the cloth-washing and the rinse waters in the aggregate, are of great quantity, highly colored, turbid, charged with suspended matter and quite capable of transforming an attractive stream into an unsightly, foul-smelling and quite unattractive waterway.

Instances like the foregoing might be multiplied almost without end. Some of the other industries which have encountered difficulties in the disposal of wastes are wire-drawing and galvanizing works, carpet mills, dyeing and bleaching works, strawboard factories, slaughtering and packing houses, breweries, distilleries, gas works, chemical and explosive works, and mines and coal washing plants.

EFFECTS OF WASTES UPON WATERWAYS

The ingredients of industrial wastes may be grouped in three main classes: first, floating and suspended matter; second, substances in solution, in colloidal condition and in an extremely fine state of suspension, and third, bacteria.

Floating and suspended substances may render the waters into which they are discharged, unsightly, and cause deposits. Such deposits, if of organic matter, often deprive the overlying water of a large proportion of its natural content of dissolved oxygen which is necessary for the maintenance of biological equilibrium and the prevention of putrefaction. Decomposition is accompanied by the generation of large quantities of gas, some of which is entrained in the mud until it has accumulated sufficiently to enable it to buoy up large masses which may be seen floating for a time upon the surface of the water only to be broken up and redeposited upon the liberation of the gases.

Dissolved substances almost always accompany the suspended matter in industrial wastes. Sometimes they are much more troublesome. They, too, cause the depletion of the oxygen supply, usually through the action of the bacteria of decomposition. Particularly objectionable and difficult to treat are those wastes containing large quantities of very finely divided suspended matter and colloidal substances. Usually impurities of this class pass along with the waters of the stream into which they are discharged and do not form deposits. However, under some circumstances such ingredients are coagulated and thrown down, sometimes by the reaction of wastes of one process with those of another, and at others by natural physical, chemical and biological processes going on in the waters.

Most industrial wastes contain bacteria. These may not be pathogenic germs. In fact, they may be decidedly helpful in the problem of disposal, rather than harmful. There are abundant opportunities in some of the industries, however, for the pathogenic organisms to escape in the liquid wastes and thus contaminate the waters into which such wastes are discharged. One of the most dreaded organisms which may be spread about in this manner is the anthrax bacillus, sometimes present in hides, skins and wool. This organism is very hardy and appears to maintain its virility through its spores for many years.

Excrementitious matter from operatives is often combined with the industrial wastes and thus the entire flow may be rendered bacterially dangerous.

Wastes may cause objectionable conditions in many ways depending upon their character and the size and condition of the waterway into which they are discharged. They may contaminate a water supply, render a stream unsightly and objectionable in appearance, cause putrefying deposits, render the natural waters putrid and offensive, poison or otherwise kill fish, and injure vegetation. Strange and contradictory as it may sound, complaint is frequently made that wastes are killing vegetation and about equally often that they are so encouraging the growth of vegetation as to do serious damage. If one complaint doesn't apply the other usually does.

It might appear that as the industries are the offenders in this field of activity, there would be few complaints from them of the conditions produced by the discharge of industrial wastes. Just the contrary is true. One of the most common complaints comes from the manufacturer to the effect that an upper riparian industry is rendering the water unfit for use in his plant.

SELECTION OF FACTORY SITES.

Enough has been stated to show how wide-spread is the trouble in disposing of industrial wastes. When about to establish a new industry or plant, the proprietors usually make thorough investigation of the quality of the water available for their use. The extent of the supply is also generally investigated and often such collateral questions as the amount of power derivable from the passing stream. But how infrequently do they make even a superficial study of the problem of wastes disposal. Yet this may be a greater and more difficult problem than that of water supply.

Expenditures of $100,000 or $200,000 for wastes treatment plants and of $25,000 to $40,000 annually for the operation of such plants are becoming more and more frequent. Capitalizing the annual expenditure of $25,000 at 5 per cent and adding $100,000 for construction cost, making no allowance for depreciation, it appears that the industry might have expended as much as $600,000 in procuring a site which would not have entailed the necessity of wastes treatment.

The selection of a suitable site for an industry producing large quantities of wastes is a matter of much importance. Even though conditions at the outset appear to be favorable they may be materially altered by establishment of new industries down-stream or by an increase of riparian population below the plant.

TREATMENT OF WASTES

When it is impracticable to afford the wastes sufficient dilution to prevent the production of unsatisfactory conditions, it becomes necessary so to modify the character of the wastes that they will not cause complaint.

One often hears that wastes cannot be so treated; that if a way were known the manufacturer would gladly adopt it. This impression that the wastes cannot be successfully treated is in many cases not true, and it may be accepted that they can be so treated as to remove their objectionable and deleterious properties before their discharge into natural waterways.

On the other hand, such treatment may be and often is a very expensive undertaking and one from which the manufacturer naturally shrinks on this account and also because he personally is not familiar with the process necessary to the accomplishment of the object.

Perhaps the most important step in the solution of this problem is the determination of the extent of treatment necessary to meet the requirements of the case. To answer this question intelligently it is necessary to know the character and quantity of the wastes produced, the character of and conditions surrounding the waterway into which they are being discharged, and their effect upon the waters in question.

The next step is to determine how best to treat the wastes to accomplish the necessary results at a minimum cost and, in any event, one which is not prohibitive. There have been instances when the plant proposed for such treatment would have cost a sum about equal to the value of the entire industrial plant of which it was to become a minor part. Such a suggestion is absurd and tends to reduce or extinguish the respect of the manufacturer for the party making the suggestion, for the officials trying to enforce the laws, and even for the laws themselves.

For the removal of the suspended matter screening may suffice under some conditions, while others may require the more complete removal by sedimentation. When the substances in suspension are of very light specific gravity and finely divided, it may be necessary to resort to chemical precipitation.

Some dissolved matters may be removed by chemical precipitation, while others can be modified in character by chemical treatment without actual removal. If they are organic and subject to putrefaction, bacterial action may be required for their oxidation, as in sewage treatment.

Certain wastes are bacterially dangerous and it may be necessary to destroy the pathogens even where the suspended and dissolved matters would cause no harm. In such cases the treatment of the wastes may be all that is essential, while in others it may be necessary even to treat the raw material as has been suggested in the case of anthrax-infected hides.

It should not be inferred from this discussion that a single process can be selected for each case, for it often requires several to accomplish the desired result.

At one plant where the author's firm has supervisory charge of the wastes disposal department, no less than seven steps have been employed at one time. These are degreasing of a portion of the wastes, sedimentation of the wastes, chemical treatment of the settled effluent, filtration of a portion and dilution of the remainder of the chemical effluent and finally the introduction of chemicals to prevent the exhaustion of the supply of oxygen in the river.

VARIATION OF TREATMENT FROM TIME TO TIME

The process adopted should in many cases be varied from time to time to take advantage of favorable or to offset unfavorable conditions. The volume of business being done may materially affect the quantity of wastes produced and correspondingly make the condition dictating treatment more or less exacting. Industrial processes frequently are changed requiring modification in the treatment methods.

In winter temperatures may be sufficiently low to retard or even prevent putrefaction under conditions which in summer would transform a natural waterway into a stinking slough.

In spring there are usually large volumes of diluting water which may make bacterial oxidation in filters unnecessary, at a time when the filters would be working under most unfavorable conditions.

All of these and innumerable other conditions must be taken into consideration if success is to be attained at a minimum cost.

ADVISABILITY OF ANTICIPATING COMPLAINT

In many cases industrial establishments which are now of great size have grown from very modest beginnings, often from merely a room or two adjacent to a water privilege which was the primary reason for the selection of the site. As the business has grown through the decades conditions have entirely changed. What was an abundant supply of water not only for industrial purposes but also for the dilution of the wastes, has now become barely adequate for industrial purposes alone and the entire flow now passes through the plant and perhaps through several plants more recently built. Thus the entire stream has become a river of industrial wastes rather than, as originally, a natural river into which a minor quantity of industrial wastes was discharged.

In all such cases there has been a collateral increase in the resident population. Now there are villages along the river where formerly were wooded lands and pastures. Such development has brought with it demands for parks and other recreation facilities, including the improvement of the natural stream for boating and perhaps for bathing purposes.

Under some conditions a proscriptive right may be acquired to make certain uses of the waters of the river, even though they be more or less hostile to the enjoyment of some privileges by lower riparian owners. The proscriptive right is often advanced in defense of the practice of discharging untreated industrial wastes into waterways and their consequent pollution. Many of the industries, particularly in the eastern part of the country, are of very long standing. The continuous operation of an industrial plant devoted to the same general kind of work for more than a century can be cited in numerous instances. In comparatively few cases, however, can it be shown that such industries are operating under conditions substantially identical with those of prior decades. Either the character of the business has changed so that processes are different and industrial wastes are greater or less in quantity and decidedly altered in character, or the business as a whole has become much greater with a corresponding increase in the quantity of industrial wastes. These changes make it exceedingly difficult in most cases to establish a proscriptive right to the acts of which complaint is made.

It should be borne in mind that in no case can one acquire a right, by proscription or otherwise, to create a nuisance. This fact has been the stumbling block upon

which many an effort to secure or maintain privileges, through court decisions, has been defeated.

The paramount lesson to be gained from experience in these matters is that it is wise to anticipate complaint of objectionable conditions whether from lower riparian manufacturers influenced by difficulties caused by the character of the water, from a community complaining because of odors and objectionable appearance of the stream, or from the farmer whose cattle will not drink the water, whose crops are killed because of inundation by polluted waters, or whose ditches and natural brooks have become so overgrown with vegetation due to the fertilizing ingredients of the waters having their origin in industrial wastes, that they will no longer serve their purpose.

The prudent manufacturer will make it a part of his routine business carefully to observe the effect of the discharges from his plant, upon the character of the water in the river, not alone in his immediate vicinity, but for a considerable distance down-stream. When conditions become noticeably objectionable he will take measures to remedy them, at the same time maintaining the valuable privilege of utilizing the stream for the disposal of his wastes to as great an extent as is compatible with the public good and the reasonable use of the waters by lower riparian manufacturers. Such a policy, if intelligently pursued, will result in many cases in avoiding expensive litigation. More important than this, however, is the fact that by maintaining the waterway in a reasonably satisfactory condition the hostility of lower riparian dwellers may be avoided. Where such a feeling is aroused by objectionable conditions, it may exert itself through legislation or through litigation in such a manner as to require the establishment of exceedingly rigid restrictions as to the use of the river or even drive the industries away. Numerous instances of the latter can be cited.

NEPONSET RIVER AN ILLUSTRATION

One of the most interesting illustrations of the industrial wastes disposal problem is that of the Neponset River Valley near Boston in Massachusetts. This river rises about 22 miles from Boston Harbor into which it discharges. Its natural drainage area is 114.14 square miles and it also receives one-third of the flow of the Charles River at Dedham, equivalent to the drainage from 66.2 square miles. The total tributary area is therefore 180.3 square miles.

The normal yield of the drainage area is probably about as follows:

Month	Mil Gal. Daily	Cu. Ft. Per Sec.	Month	Mil Gal. Daily	Cu. Ft. Per Sec.
January	216	334	July	31	49
February	304	470	August	45	69
March	492	762	September	40	62
April	356	551	October	76	117
May	190	294	November	135	209
June	84	130	December	176	272
Mean				178	276

The actual flow is much more uniform than the natural flow would be because of the regulating effect of the storage reservoirs.

The State Department of Health reported at one time that there were about 30 mills discharging more or less wastes into this river. Before prohibitory statutes were passed, one wool scouring concern abandoned its location. Some manufacturers have diverted a portion of their business to other plants and one has abandoned the manufacture of one line of goods, thus avoiding the production of a large quantity of liquid wastes which were very difficult to treat.

Eleven manufacturers have provided sedimentation tanks and ten have constructed strainers and filters of cinders, coke or sand. Some have adopted chemical precipitation as a means of improving the efficiency of natural sedimentation. Treatment plants have been provided in nearly all cases where the wastes require treatment, some of which were described by the writer in a paper entitled "The Cleaning Up and Improvement of a Stream Polluted by Sewage and Trade Wastes," published in *Engineering and Contracting*, Aug. 9, 1916.

In 1902 the Massachusetts Legislature passed an act directing the State Board of Health,

"* * * * to prohibit the discharge of sewage * * * or every other substance which may be injurious to public health or may tend to create a public nuisance or to obstruct the flow of water, including all waste or refuse from any factory or other establishment where persons are employed, *unless the owner thereof shall use the best practicable and reasonably available means to render such waste or refuse harmless.*

"Section 2. The Board shall consult and advise with any such owner at his request or of its own motion as to the best practicable and reasonably available means of rendering such waste or refuse harmless, having regard to the circumstances and requirements of the situation and to the industrial interests involved." (Chap. 541, Acts of 1902.)

It is interesting to note that it was the intention at the time this original act was passed, to have reasonable regard for the manufacturing industries, not requiring them to go to extremes in the treatment of their wastes unless the exigencies of the situation required. In other words, incorporated into this statute was the "rule of reason."

At the time of the passage of this statute industrial wastes treatment in this country was in its infancy and progress in improvement of conditions in the Neponset Valley was naturally somewhat slow. In 1906 it appears that public sentiment had been so aroused that it was possible to pass an act in which the "rule of reason" was much less evident than in the earlier act. The only reference to it in the 1906 act was that the Board was to advise the owner of the factory as to the *"best practicable and reasonably available means of rendering the wastes or refuse harmless."* The clause "having regard to the circumstances and requirements of the situation and to the industrial interests involved" was omitted from this act.

During the next 10 years many efforts were made to secure additional and usually more drastic legislation, in spite of the fact that the manufacturers expended large sums of money in an effort so to modify their wastes before their discharge that they should not endanger the public health nor tend to create a nuisance. Perhaps the culmination of these efforts may be said to have been embodied in a proposed act—Senate 113—presented to the Legislature for its consideration in the year 1916, which read as follows:

"Section 1. Any person, firm, corporation or group of individuals who shall cause, either directly or indirectly, the pollution of the waters of any river in this commonwealth, shall be punished by a fine of not more than one hundred dollars for every day which said pollution continues after notice from the health commissioner that such nuisance be abated.

"Section 2. A river shall be held to be polluted within the meaning of this act whenever by the introduction or discharge into its waters of any foreign or deleterious substance: (a) it shall give out any noxious or offensive smell, odor or vapor, which condition is a menace to the public

health; (b) it shall become discolored in such a way as to be unsightly or offensive, or (c) it shall become poisonous or dangerous to fish or animal life subsisting therein, or to live stock using the same as a drinking place; (d) it shall become injurious to vegetation in its vicinity.

"Section 3. The health commissioner of Massachusetts shall be charged with the enforcement of the provisions of this act and shall determine when the waters of any rivers are being polluted as aforesaid.

"Section 4. All acts or parts of acts inconsistent herewith are hereby repealed."

There are several provisions in this act which would be exceedingly oppressive if applied with literal interpretation of the act and without reading into it the rule of reason. One of these is the provision for a fine not to exceed $100, for every day which the pollution continues after notice from the Health Commissioner that such nuisances be abated. In some instances, even if prosecuted with diligence plants for the elimination of those ingredients of wastes which caused the pollution, could not have been built in less than six months' time.

Aside from the broad scope of the specifications of a polluted river within the meaning of this act, the Health Commissioner was charged with its enforcement and apparently made the sole judge to determine when the waters of the river were being polluted, as specified by the act. Should such an act be found constitutional, which is subject to some doubt, it would apparently deprive the alleged offenders of their rights to a hearing before the courts of justice.

Happily this act was not passed and is introduced here merely as an example of the extent to which industries or communities may go after they have become thoroughly aroused by long-continued objectionable conditions. It is confidently believed that such drastic legislation can always be avoided, and probably also its suggestion forestalled, by prudent foresight on the part of manufacturers in preventing objectionable conditions caused by the discharge of their untreated wastes.

PROGRAM FOR SOLUTION OF PROBLEM

In many cases where manufacturers have been confronted with a serious problem in connection with the disposal of their industrial wastes, they have been inclined to attempt its solution without first acquiring a clear understanding of the scientific principles involved, either in the production of the conditions which caused the trouble or in the processes available for the treatment of the wastes to render them less objectionable. The treatment of industrial wastes usually is a subject entirely different from that with which the manufacturers have to deal in their usual business and in which they are primarily interested, all other matters such as the treatment of their waste liquors, being of only secondary interest and importance from their point of view. They have, therefore, often adopted a plant poorly adapted to the use they desired to make of it. Sedimentation tanks, for example, are often found which are entirely inadequate for the purpose, although this process is most simple. All sorts of filters have been designed and constructed, but usually without the remotest conception of the scientific principles involved in the treatment which they were to accomplish.

Another fruitful source of misdirected energy has been the desire to recover from the wastes ingredients of value such, for example, as the grease and fertilizing ingredients in municipal sewage. Industrial wastes, like sewage, often contain ingredients which have a market value, and every encouragement should be afforded to the recovery of such products. As economic conditions change in the future there will be a greater need of economizing in this direction, and it is to be expected that processes will be devised for the profitable recovery of such ingredients. The fact that such processes may not be available at the time the problem first presents itself, but will probably be available at some future time, is not a justifiable reason for making no effort for its solution.

Whenever an industry is confronted with a problem of this kind a program for its solution should be carefully worked out before making expenditures upon construction. In fact, the studies necessary to the preparation of such a program may disclose other means of solution, involving relatively small cost.

First a study should be made of the waterway, to note its condition and physical characteristics, such as size, velocity of flow, depth and temperature, and a similar study of wastes to determine their quantity and character. With the information gained in this manner it will be possible to form an opinion as to the extent of treatment required to meet existing conditions.

Next, the kind of treatment and the plant required to provide such treatment, should be determined. The methods selected should be those required to give the results which may be desired within a reasonable period of time in the future when perhaps conditions may have become decidedly different from those obtaining at the time the investigation is made. Such methods should always be selected and reported with the clear reservation that better processes may subsequently be devised.

Following the selection of methods should be the construction of plant. Here it may be wise to proceed progressively, building first the system of drains required for the collection of the wastes and for their discharge at a single point. After this has been done further investigations based upon the measurement and analyses of the combined wastes, may be desirable. When the collecting system shall have been completed, it will be possible to provide the first part of the treatment process, such for example as screening or sedimentation. After this has been accomplished still further investigations may be desirable to determine, first, the efficiency of the plant already installed and, second, the next process of treatment which should be provided and the probable results to be obtained.

However much or little may be required, it is important to build in accordance with an intelligently devised plan and in harmony with such additional processes as may follow. Thus many expensive mistakes will be avoided and advantage taken of all opportunities to provide an economical arrangement of plant. The following of such a course will often result in avoiding expensive pumping of the wastes, or the treatment of excessive quantities due to the inclusion of relatively clean waters which may not require treatment under the local conditions.

The final step, and undoubtedly the most important, is the intelligent operation of the plant. Whether the processes involved are simple or complex the supervision and control of operation should be based upon a knowledge of the conditions in the river, the character of the wastes and the scientific principles involved in their treatment.

Synopsis of Recent Metallurgical and Chemical Literature

General Metallurgy

Recent Operations at the Consolidated Mining and Smelting Company.—In a paper given at the recent mining convention held in British Columbia, S. G. BLAYLOCK, general manager of the Consolidated Mining & Smelting Company, Trail, B. C., told of developments at his company's plant since the war started. Just before the war was declared and the markets were overflowed, and everyone expected a panic, the Consolidated Company had its vaults full of silver which it could not sell. Shortly after the war started, however, conditions began to improve and the markets and the stock exchanges started again and metals moved. Zinc jumped to a fabulous price. The company had been primarily a producer of lead, gold and silver. Some experiments had been conducted with zinc, but the men in charge of the work had enlisted. The experiments were started again, however, and a contract was taken on with the Imperial Munitions Board to make zinc. A plant was built, which cost a great deal more than was expected as so many things had to be changed as the process was perfected. At present about 40 tons per day of electrolytic zinc is being produced. A copper refinery was also built when the copper shortage became acute, and the company is producing 30 tons of refined copper per day. A copper converter plant was also constructed. Just about the time the copper plant was being built the company was notified by the concern from which it had been buying hydrofluosilicic acid for the lead refinery that it would either have to make a contract for three or four years ahead at about double the price or they would furnish no more. Hence a hydrofluosilicic acid plant was built and that necessitated a sulphuric acid plant, which was also built. These have been operating for several months. Since the building of the first sulphuric acid plant the requirements have increased so that the plant has been doubled. At present about 1600 men are employed and the following products are being made: electrolytic copper, copper sulphate, electrolytic lead, lead pipe, shrapnel, wire, electrolytic zinc, gold, silver, sulphuric acid and hydrofluosilicic acid. All of these with the exception of lead, gold and silver have been accomplished since the war started and were caused primarily by the need for the material by the Munitions Board. The author stated that 300 men—practically every unmarried Canadian or Britisher—had gone to the front.

Electrolytic Zinc

Difficulties in the Electrolytic Zinc Process.—At the recent mining convention held in British Columbia, Mr. THOMAS FRENCH of the Nelson Electrolytic Zinc Company, Nelson, B. C., read a paper on "Some of the Difficulties in the Electrolytic Zinc Process." He said one of the greatest difficulties both in early work and at the present time is in the roasting of ore so as to get a high extraction of the zinc. Mr. French's father, A. Gordon French, had used niter cake successfully in roasting and had obtained high total extractions, but it was later proven by the author to be unnecessary to use niter cake if certain precautions were taken in roasting. He said he had roasted a great number of ores and had generally obtained 90 per cent extraction. The Consolidated Company at Trail became interested in the process and made experiments in a large Wedge furnace, with seven hearths and 22 ft. 6 in. in diameter with high extractions. The author said he understood that the Consolidated Company was only obtaining 65 per cent extraction at present and that at Anaconda somewhat similar results are also being obtained. He thinks that these low extractions are due to improper roasting. The author stated that his father had found that manganese, contrary to the general opinion, was necessary in the zinc solution for the successful deposition of zinc. One of its main functions is to prevent the disintegration of the lead anodes. In addition to that the manganese has several other effects, such as giving a lower current consumption, and providing a valuable by-product of manganese dioxide. By the use of manganese the anodes are not absolutely protected, but with the addition of a little sulphate of soda the protection is absolute. Most of the manganese is deposited as manganese dioxide at the anodes and the remainder left in solution flows from electrolytic vats, along with the acid that has been set free, and is used again in the operation of dissolving the roasted ore, for the purification of the solution. In his father's Canadian patent specification dealing with the electrolytic part of the process he claims "the electrolyzing of a solution containing sulphate of zinc and sulphate of manganese for the recovery of zinc and of manganese." And also of a solution containing sulphate of zinc, sulphate of manganese, and sulphate of sodium for the recovery of zinc and of manganese dioxide. In the American patents, the claims—in order to save duplication of patents—are drawn up rather differently. They claim the electrolyzing of a solution containing sulphate of zinc, sulphate of manganese and sulphate of sodium. It was considered that it was quite safe to do that, as sulphate of sodium exists in practically every ore and collects in the solution.

Utilization of Waste Leather

London Chemical Industry Club Meeting.—An account of the first meeting of the new Chemical Industry Club in London is given in the *Chemical Trade Journal and Chemical Engineer*. The membership, for the present, is restricted to members of the London Section of the Society of Chemical Industry, and although among those who have signified their intention of joining are many living outside the London area, yet the general invitation of the committee of the club to all members of the section to attend the first meeting was responded to to such an extent as to fulfill the most sanguine expectations of those who are working so hard to make the new venture a success from the start. The actual membership at present is about 350, but a total of 500 is regarded as easily attainable, and there are one or two enthusiasts who feel that, with a subscription of only 2s. 6d., the whole of the 1000 members of the London Section should join. To assist the finances a number of donations have already been received. A paper was read by Mr. M. C. LAMB, and dealt with a subject upon which, at the request of the War Office, he has undertaken an investigation, viz., the commercial utilization of discarded army boots and other waste leather. The object of the paper was to incite the formulation of further suggestions for the utilization of this waste product on a commercially profitable scale.

The present policy of the Director of Army Contracts is to have old army boots sorted into four categories, the first three of which are sold for civilian use, and the remainder are available for waste. The actual quantity, which many of the members were anxious to know, was not stated by the author of the paper, the impression being not that he did not know, but that reasons of policy forbade the information being given. He indicated, however, several interesting directions in which experiments are being carried out to make use of discarded army boots. The most promising at the present moment is for the purpose of road-making. By dry distillation the quantity of charcoal obtained has been found to be about 25 per cent of the waste leather used. Then the uppers have been found to give some 15 per cent of extractable grease, and a quantity of crude ammonium sulphate has also been recovered. Another direction in which experiments have been made is in the treatment of the waste leather as an artificial manure; finely powdered and mixed with niter cake. However, not very successful results have been obtained, owing to the presence of soda salts. Decolorization carbon is another possible recovery, which should have commercial possibilities, having regard to the present shortage. Leather boards were also mentioned as likely to be attractive commercially, while a glue of inferior quality has also been evolved. Mr. Lamb's paper certainly created the interest which was desired. The use of waste leather in some of the directions indicated is not new, but the quantity which will be available from discarded army boots will be so large that considerably greater ingenuity may well be given to the problem in the knowledge that the supply will not fail for a very long time. Specimens of the by-products mentioned were shown to the members of the club.

Dust Collection and Ventilation

Dust Collecting and Ventilating in Factories.—In an address delivered on May 8, 1917, before the Illinois Manufacturers' Association and the National Safety Council, Mr. W. G. CLARK, president of the Clark Dust Collecting Company, Chicago, Ill., gave some interesting data on dust collection. Some of the most prominent industries in which dust collecting and ventilating systems can and should be used are as follows: Metal smelting and refining works, ore separating and mixing, carbide of calcium plants, crushing and grinding plants, cement mills—all departments, cereal mills, grain elevators, chemical works, gypsum works, hydrating plants, blast furnaces, graphite mills, asphalt manufacturing, flour mills, fertilizers, gum factories, cork factories, coal mines, phosphate plants, lead works, on sand-blast machines, malt houses, potteries, paint mills, shoe factories, polishing plants, wood-working factories, peat coal briquetting works, breweries, emery mills, foundries, collieries, gas works, drying plants, oxide plants, textile mills, sugar factories, jute mills, porcelain works, rubber factories, spinning mills, tanneries, tobacco factories, felt boot, tire factories, dextrine factories, munition plants, etc. Referring to metal smelting and refining works the author said there was a time when they let escape through the stacks from their furnaces valuable oxides and other valuable metals that they are now collecting and saving, and selling at a very fancy price, some places realizing a profit from $100 to $400 per day. In the cement industry there is a great deal of interest being taken in solving dust problems. There was a time when cement mills thought that dust was unavoidable, and that it was part of their business to have a lot of dust floating around, that it was part of the game, but in late years we notice a marked change in their opinion. Cement dust is valuable. They spend hundreds and thousands of dollars in pulverizing and grinding machinery to pulverize their raw and finished material into a fine powder such as cement is, and they figure it is foolish to let it escape and get away from them in this condition. Therefore, they are putting in dust systems to reclaim this fine dust. It reduces the cost of manufacture, and economical manufacturing of all products is looked after more carefully than in former years. They also figure that by eliminating the dust the sanitary condition is so much improved that it pays to have this improvement, as they secure a better day's work from their employees, and save wear and tear on their machinery. Irritating dust in sand blasting plants is also receiving the attention of all classes connected with this industry, from the State factory inspector, employee and employer. This is a very hazardous and very unsanitary business at its best, and the better condition existing in these industries the more work is accomplished, the less wear on men and machinery, and it is remarkable to see the interest that the conscientious employers are now displaying in this direction. On poisonous gases the same interest is being shown, and the U. S. Government is pushing the rigid investigation on poisonous dust, all of which combined with the willingness on the part of successful smelters are reaching grand results.

Aluminium

Action of Acetic Acid on Aluminium.—A paper on this subject was presented by RICHARD SELIGMAN and P. WILLIAMS at a recent meeting of the London Section of the Society of Chemical Industry and published in the April 30, 1917, issue of the *Journal* of the society. In an earlier paper (*Jr. Soc. Chem. Ind.*, 1916, 35, pg. 88) the action of boiling concentrated acetic acid was described. In the present paper the action of boiling acetic acid of lower concentrations and of acetic acid of all concentrations at ordinary temperatures is described. The action of boiling acids of lower concentrations has been found to be analogous to that of the solutions containing between 100 per cent and 50 per cent acetic acid previously examined, and it has been found that the rate of dissolution of the aluminium rises continuously until the concentration of the acid falls to 1 per cent. With acids of lower concentration than 1 per cent it is not possible to obtain reliable figures owing to the fact that the metal becomes coated with a protective skin which interferes with the action of the acid. Even with solutions containing 5 per cent acetic acid the numerical results become erratic owing to the same cause, but it is, nevertheless, possible to conclude definitely that where unprotected by a coating the aluminium dissolves at an ever-increasing rate.

"The rate of attack by cold acetic acid is in general small. As in the case of boiling acids, the rate of dissolution increases with increasing dilution of the acid, and the highest rate so far noted took place with a solution containing 0.02 per cent acetic acid. The rate of dissolution is frequently high at first, but rapidly falls off and then remains approximately constant over pro-

longed periods. This phenomenon has not been explained so far but does not appear to be of practical importance.

"In dealing with cold acetic acid it has been possible to show conclusively the effect of oxygen in promoting local action. Acids which normally cause local action of a serious kind can be made to act perfectly uniformly if the oxygen be entirely removed or if it be replaced by some inert gas. No doubt this accounts also for the fact that acids which in the cold or even at temperatures slightly below boiling point cause local action, nevertheless act perfectly uniformly at boiling temperatures when the oxygen is rapidly removed in the course of ebullition. In the case of cold acids it has been found, moreover, that the actual rate of dissolution is increased by the presence of oxygen, and may be reduced to less than half its original magnitude if the oxygen be replaced by hydrogen.

"Here again it may be well to point the practical moral of the observations made. Vessels used to contain solutions of these acids should not be allowed to remain wet for prolonged periods after being emptied and before cleaning. In such cases the metal is exposed to the action of thin films of acid subjected to intense aeration and, as practical experience has amply demonstrated, local attack frequently ensues. The metal should be purged as soon as possible of any remaining acid and, where practicable, left dry.

"One of the original objects of this research was to find an explanation of the fact that in stills used for the distillation of acetic acid the still proper was often found to have a prolonged life, whereas the condensers, notably in their lower part, were frequently subjected to rapid deterioration and to local perforation. It would appear that the effect of oxygen in promoting and localizing such attack affords a sufficient explanation of this phenomenon, because it is precisely at the point where this attack has been observed in condensers that oxygen would have access to surfaces bathed in hot acids.

"The question arises whether difficulties due to this cause could not be completely obviated by the introduction of some neutral gas at this point, or by preventing altogether access of oxygen to the condenser."

The effect of various foreign substances was also discussed by the authors. "It has been found that with dilute acids of about 10 per cent concentration the addition of up to 1 per cent of sodium chloride, potassium bromide, potassium iodide or potassium nitrate has practically no effect in the case of boiling acid, whereas an equivalent amount of sodium sulphate raises the rate of dissolution appreciably. In cold 10 per cent acetic acid, however, 1 per cent of sodium chloride is sufficient to raise the rate of dissolution tenfold, whereas potassium bromide effects a much smaller increase in the rate of attack, and potassium iodide and potassium nitrate none at all; 0.5 per cent of sulphuric acid in the form of sodium sulphate raises the rate of dissolution fourfold in the case of dilute acid at normal temperature.

"The most serious effect of the addition of the substances experimented with was noted in the case of 80 per cent acid at boiling point. Here the rate of dissolution is raised by 1 per cent of sodium chloride from 290 to 16,000. By 1 per cent of potassium bromide the rate is only increased from 290 to 485, while potassium iodide and potassium nitrate may be said to have no effect; 0.5 per cent of sulphuric acid in the form of sodium sulphate increases the rate of dissolution."

Molybdenum

Metallurgy of Molybdenum in Canada.—In *National Progress* for June, 1917, G. C. MACKENZIE gives some data on the development of the mining, concentration and reduction of molybdenum ores in Canada. Canadian molybdenum purchased by the Imperial Munitions Board of Ottawa in the form of molybdenite concentrates is being converted into ferromolybdenum in Canada before being exported to Europe, and as it is possible to manufacture the ferroalloy from concentrates containing less than 85 per cent MoS_2, the following scale of payment has been adopted: For concentrates containing not less than 85 per cent molybdenite, $1.09 per pound of contained MoS_2; not less than 80 per cent, $1.05 per pound MoS_2; not less than 75 per cent, $1.02 per pound MoS_2; not less than 70 per cent, $1 per pound MoS_2. The mining and metallurgical treatment of Canadian molybdenum ores has up to 1916 played a very small part in the world's production. This has been due to various factors, chief of which have been the limited demand for the mineral and the unattractive prices, together with the fact that no Canadian mine had until 1916 been developed to the point of a steady producer. The Department of Mines has conducted a large amount of experimental work on concentration and has finally adopted a modification of the Wood water film flotation machine (invented by Henry E. Wood of Denver, Col.), which is used on a semi-commercial scale in treating ores at the Department of Mines Laboratories. The plant has operated since June, 1916, and up to Feb. 1, 1917, has treated 2397 tons of crude ore and picked flake with the production of 34.85 tons of pure molybdenite in the form of a concentrate averaging 80 per cent MoS_2. The ore treated contained 1.84 per cent molybdenite and the actual molybdenite shipped has been 79.09 per cent of the total amount received. The total recovery would be slightly over 80 per cent, as no account has been taken in this calculation of the several tons of middling product in process of milling.

Among the companies who are operating in Canada to produce molybdenum are The International Molybdenum Company of Orillia, Ont., who are under contract with the Imperial Munitions Board; The Canadian Wood Molybdenite Company, The Spain Mines, County of Renfrew, The Chisholm Mine, The Renfrew Molybdenum Mines, in Ontario; The Molly Mine in the Kootenay, and The Molybdenum Mining & Reduction Company of Vancouver, British Columbia.

Among the processes used in the manufacture are the Elmore vacuum flotation process, the Minerals Separation process, the Hoover valveless apparatus, and the Callow pneumatic flotation process.

Technical Positions Announced by Civil Service Commission.—The present demand for technical men by the Government gives rise to the constant creation of new positions. At present physicists, metallurgists, chemists, geologists and metallographists are needed. Full information regarding these positions together with application blanks may be obtained from the Civil Service Commission in Washington, D. C., and from the secretaries of the Civil Service Boards in Boston, Philadelphia, Atlanta, Cincinnati, Chicago, St. Louis, Seattle, San Francisco, New York and New Orleans.

Recent Metallurgical and Chemical Patents

Soldering

Soldering Aluminium.—A composition for soldering aluminium is patented by FRANCIS E. J. LITOT, of Wilkinsburg, Pa. It consists of an alloy of zinc, lead, and tin in the proportions of 25, 55 and 45 parts respectively. This composition is claimed to form a solder which is very fluid and has a low melting point and is therefore suitable for soldering aluminium. It is also claimed to form a joint which has great endurance under either mechanical strains or weather, and its melting point is so low that danger of injuring the aluminium during soldering is entirely avoided, even in the hands of an unskilled workman. (1,224,941, May 8, 1917).

Iron and Steel

Process of Treating Iron Ores.—A process for treating iron ores, patented by EDWARD F. GOLTRA of St. Louis, Mo., consists essentially in preheating or calcining the ore and its gangue at a temperature and for a sufficient length of time to drive off the moisture in the ore and to render the gangue easily separable from the ore. The ore is subjected to vigorous tumbling which separates the gangue and the product in this shape is then subjected to a strong blast, which removes the gangue from the ore. The concentrated ore then is subjected to blast-furnace treatment. Fig. 1 illustrates

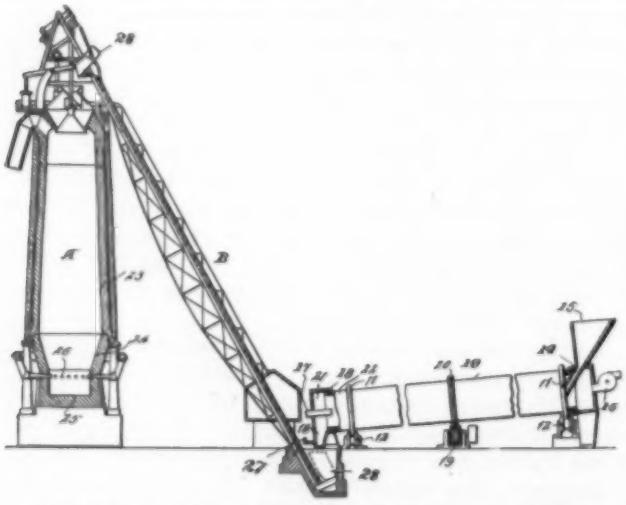


FIG. 1—GOLTRA'S PROCESS FOR TREATING IRON ORES.

the process. Ten is a rotating cylindrical kiln in which the ore is liberated from its moisture. At the lower end of this kiln is a burner and a blast pipe. The blast is intended to wash the charge and to penetrate in between the gangue and the values, loosening the latter from the gangue and in this manner making the whole product more suitable for blast furnace treatment. The rest is self-evident. (1,216,109, Feb. 13, 1917.)

Process for Making Ferro-Phosphorus.—JOHN JEFFERSON GRAY, JR., of Rockdale, Tenn., has patented the making of ferro-phosphorus in a blast furnace. The process consists in charging the furnace with a suitable mixture of iron-bearing material, phosphatic material, fluxing material and excess carbon, the latter thus maintaining free uncombined carbon in the fusion zone. The temperature in the fusion zone should be high enough to reduce the phosphorus present in the phosphatic material to the elemental state in the presence of said free carbon. The temperature of the fusion zone is 2200 deg. Fahr. to 3100 deg. Fahr. This high temperature is produced by preheating the air blast to 900 deg. Fahr. The stock line temperature should not be higher than 700 deg. Fahr. The iron ore stack in the furnace should be high and have a slow downward motion so as to facilitate contact between the iron and the ascending phosphor vapor. (1,220,416, March 27, 1917.) A charge as used is given in the following table:

	Lb.	Lb.
Air		9,720
Phosphate rock:		
Tricalcium phosphate, $Ca_3P_2O_8$	1,050	
Calcium fluorid, $CaFl_2$ / Calcium carbonate, $CaCO_3$ / Calcium sulfate, $CaSO_4$	224	
Silica, SiO_2	63	
Iron, Fe_2O_3	63	
Total phosphate rock		1,400
Iron ore:		
Fe	700	
SiO_2	252	
$Al_2O_3 + H_2O$	448	
Total iron ore		1,400
Silica, sand or flint:		
SiO_2	576	
K_2O	64	
Total		640
Coke, as carbon, C		1,840
		15,000

Copper, Lead and Zinc

Hydrometallurgy of Copper.—A patent to JOHN H. GREENWAY, of Warren, Ariz., relates to the extraction of copper from ores and especially from oxidized ores. Sulphuric acid solutions are employed for the leaching. In general the process consists in passing a solution of sulphuric acid over ores containing copper and iron until the solution is substantially neutral. This neu-

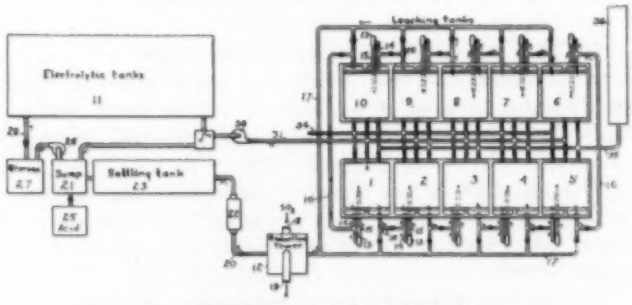


FIG. 2—GREENWAY'S PROCESS.

tral solution is then subjected to the action of sulphur dioxide which reduces the ferric sulphate to the ferrous state. The solution is then electrolyzed for the recovery of copper. The ferrous sulphate in the solution has no detrimental action on the deposition of the copper. Fig. 2 illustrates this process and needs no further explanation. (1,224,458, May 1, 1917.)

Electrolytic Zinc.—A patent has been granted to URLYN CLIFTON TAINTON of Johannesburg, Transvaal, South Africa, for the electrolytic recovery of zinc from ores or other zinc-bearing materials. One method of carrying out the process is as follows: The ore is first reduced to such a size as to render the zinc values readily accessible to the solvent. If the ore is sulphide it is primarily roasted to make it soluble in acid. The ore thus prepared is then treated with sulphuric acid. This may be effected by percolation, leaching or agitation, the last mentioned being preferred. The acid is added in quantities just sufficient to take up the zinc in the ore and leave a neutral solution. This solution is then freed from solid matter by filtration or settling

and a further amount of acid added. In filtering it is desirable to filter while hot so as to keep the zinc sulphate in solution. The acid and the zinc content should be fairly high, say 140 grams of zinc per liter and from 50 to 300 grams, preferably 75 grams of free sulphuric acid per liter. The solution then is electrolyzed with insoluble anodes such as lead and any suitable cathode. The amperage should be from 50 to 300 amp. per square foot. Usually the electrolysis is conducted until 60 grams of the zinc have been removed from the solution. The solution is then regenerated by dividing it into two portions such that one portion contains as much free acid as the whole of the original solution did before electrolysis. One portion of the solution is then kept separate while the other portion is used for dissolving fresh ore until it is again neutral. This solution, after filtering, is added to the portion kept separate bringing the whole solution up to standard conditions again. During the preparation of the solution iron is precipitated by the last amount of ore added to it to bring it to neutrality. This eliminates to a marked extent the accumulation of iron salts in the electrolyte. The quality of the metal deposited under these conditions, it is claimed, is very good and may be used directly as a galvanizing coating for the protection of iron against corrosion. If zinc is desired in the form of solid metal the cathodes must be of such a nature as to permit their stripping. The zinc then may be detached, melted and cast. If zinc sheet cathodes are used no stripping is required. (1,210,017, Dec. 26, 1916.)

Gold and Silver

Flotation and Cyanidation Combined.—HARRY LOUIS FRIBERGER, of Eureka, Kan., has patented the separation of the cyanicides by means of flotation before these have any detrimental action on the cyanide solution. To the ore, ground to the required fineness and mixed with the cyanide solution, a frothing medium is added. This latter is prepared by dissolving a resinous substance, such as rosin, in alcohol, the amount of rosin used being 25 and 50 per cent of the amount of alcohol used. To this solution is then added an amount of alkaline hydrate, best caustic soda, until the solution is neutralized. From this liquid the alcohol is distilled off and reused. The product left will be either liquid, semi-liquid or solid according to the amount of alcohol left in the product. The residue is soluble in water and acts as a satisfactory frothing medium. A typical example is given in the patent. The process as a whole is simply a combination of the regular cyaniding practice and flotation. Any practical type of machinery may be used. It is claimed that this practice gives a recovery of 90 per cent of the gold and 85 per cent of the silver. Often 95 per cent of the copper and as high as 80 per cent of the lead are floated. (1,224,917, May 8, 1917.)

Treatment of Refractory Auriferous Ores.—JOHN HENRY NIEMANN, of Adelaide, South Australia, has patented an improved method of economically extracting, separating and recovering the precious metal constituents of refractory auriferous ores containing selenium or seleniferous material yielding a salt or compound of selenium. Briefly the method consists in treating auriferous ores with a weak cyanide solution in the presence of seleniferous material under non-oxidizing conditions. The gold is then precipitated from the solution in slimes in a non-oxidizing atmosphere. The slimes are distilled to recover values other than gold and the gold residues are retorted under reducing conditions. (1,222,789, April 17, 1917.)

Alloys

Bearing Metal.—HENRY K. SANDELL of Chicago, Ill., has patented an improved bearing-metal alloy. The alloy consists of copper and antimony, in substantially the proportion of two parts by weight of the former to one of the latter, together with a small proportion of lead, and preferably in addition thereto a percentage of nickel. In general it appears that the antimony possesses the property of crystallizing the copper, thereby greatly increasing the hardness of the alloy and lowering the frictional resistance. The nickel toughens the alloy by binding together the highly crystalline mass, increasing thus the tensile strength and preventing disintegration under abrasive action. A typical alloy for supporting the steel shaft of a 10-kw. dynamo running 1800 r.p.m. would be, in parts of metal used, copper 4, antimony 2, lead 1 and nickel 1. It is claimed that alloys of this type will permit a bearing to run for an indefinite period without lubrication and without showing substantial wear. The alloy shows no overheating tendency, does not itself score or score the shaft and is in all respects satisfactory for use as a bearing-bushing operating under sliding friction, either without lubrication or with very little lubrication at moderate bearing pressure and high speeds. (1,223,001, April 17, 1917.)

Uranium

Uranium.—Two patents granted to CHARLES L. PARSONS, chief chemist of the Bureau of Mines, and dedicated for the free use of the people, have been granted for a process for the purifying of uranium compounds and for preparing oxides of uranium.

The process for the preparing of uranium oxide enables pure black oxide of uranium to be obtained for the use of producing ferro-uranium. Experiments in the production of uranium steel itself are now under way. By the use of the processes above mentioned the production of pure oxide of uranium is claimed to be very much facilitated and cheapened. Also the product is obtained in a much purer form than has ever been acquired heretofore. Uranium oxide so obtained is also valuable for coloring glass, giving to glass the golden yellow color seen in some of the newer forms of automobile headlights. The chief claims of the first patent (1,224,013) are as follows:

1. The process of preparing uranium dioxid, consisting in reducing a uranium compound in a fused bath with carbonaceous matter.

2. The process of preparing uranium dioxid, consisting in fusing a mixture of a uranium compound and a flux in the presence of carbonaceous material.

(6) The process of preparing uranium dioxid, consisting in fusing a mixture of finely divided alkali metal uranate, flux and carbonaceous matter, cooling, dissolving out soluble matter and washing the residue.

(7) The process of preparing uranium dioxid consisting in fusing a mixture of a uranate and a flux in the presence of a reducing agent, dissolving out soluble matter, washing successively with an alkali solution, water and an acid.

The chief claims of the second patent (1,224,014) are as follows:

1. The process of purifying uranium compounds, which consists in fusing the same with a flux incapable of forming a soluble compound with the uranium and then dissolving out the soluble matter.

2. The process of purifying uranates from vanadium and the like, consisting in fusing the uranate with a flux incapable of forming a soluble compound with the uranium, dissolving out the soluble matter and washing the residue.

(4) The process of purifying an alkali metal uranate, consisting in fusing the same with an alkali metal chlorid, and washing the resulting mass.

Organic Electrolysis

Electrolysis of Organic Compounds.—In order to minimize the disturbing effect of the inactive electrode in electrolyzing organic solutions, Dr. ALFRED PIGUET, of Basel, Switzerland, proposes to prevent the emulsion from reaching this electrode. The patent is assigned to the Society of Chemical Industry, of Basel, Switzerland. The result is obtained by reason of the difference in specific gravity of the electrolyte and of the specific gravity of the organic compound to be electrolyzed. If care is taken in choosing the difference in these specific gravities, sufficiently great, it is stated to be easy to produce a good emulsion in the neighborhood of the active electrode without the emulsion reaching the other electrode. An example of this method is given in the reduction of nitrobenzene to azobenzene, which is described as follows:

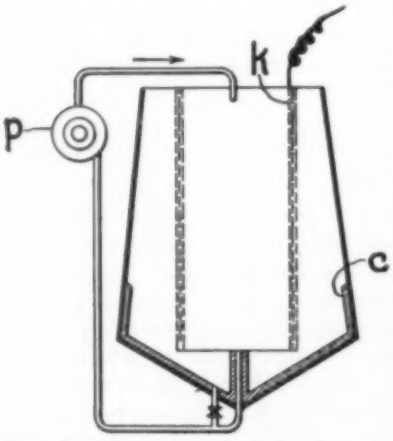


FIG. 3—ELECTROLYTIC CELL FOR ORGANIC SOLUTIONS.

"Into the middle part of a vessel of iron, having the form of a truncated cone (Fig. 3), which serves also as anode and has a conical bottom lined with a layer of cement *c*, is placed a cylinder *k* formed by several layers of iron-wire trellis acting also as cathode. The whole apparatus is filled up with soda lye of 2 to 5 per cent and with nitrobenzene, which latter sinks to the bottom of the recipient by reason of its higher specific gravity. A small rotatory pump *p* turning at a high speed causes the formation of the emulsion and the slow circulation through the cylindrical cathode. At the bottom of the vessel collects a mixture of azobenzene and nitrobenzene, which is maintained continuously in circulation by the pump. The reduction is achieved when all nitrobenzene has disappeared. The electrolysis is effected with 10 amp. per square decimeter and 2.5 to 3 volts at 85 to 95 deg. C."

Other processes mentioned are, preparation of hydrazobenzene from azobenzene, preparation of hydrazobenzene from nitrobenzene, preparation of hydrazotoluene, and oxidation of isoborneol to camphor. (1,225,052, May 8, 1917.)

Interesting Uses of Magnetic Separator Pulleys

Magnetic separator pulleys have been put to work in an increasingly large number of industries during the past 10 years. They are useful wherever it is desired to continuously remove the magnetic content from non-magnetic bulk material. For example, they are used with success in removing pickheads, coupling pins, etc., from coal passing to a crusher which would be damaged by the entrance of such material. They are used for similar purposes at phosphate rock mines and quarries. In the production of sulphite fibre paper stock, they are used to remove tramp iron and steel from the wood chips before these are delivered to the sulphite tanks. They are also used in the production of cement, gypsum, limestone, clay for terra cotta manufacture, as well as in the freeing of grain, spices and tobacco from bits of iron or steel before grinding. They also find employment in city refuse disposed plants, for removing tin cans, horse shoes, nails, etc., from the worthless material.

An example of an interesting application is found in the sugar industry, an industry in which it would seem there would be no need for such equipment. Magnetic separators made by the Cutler-Hammer Manufacturing Co., Milwaukee, Wis., and known as C-H magnetic separators are in use in a large number of sugar plants, a report on the use in one, the Revere Sugar Refining Co. plant, giving an idea of the work done in this industry.

The separator in this plant is installed to remove iron rust or iron oxide from animal charcoal which is collected by it while passing through the ovens and being baked. This baking process is necessary to eliminate from the charcoal the impurities which it has absorbed from the sugar. The magnetic material is especially prevalent after the retort has been repaired. Under ordinary conditions the magnetic pulley is energized only part of the time, two weeks out of a month or so, this being sufficient to keep the iron oxide out of the bone charcoal so that trouble with iron coloring in the sugar is prevented.

The magnetic pulley in this installation is placed in the delivery end of the conveyor which carries the animal charcoal from the retorts to the elevator. The material from which the iron content is to be removed is carried about 1 in. deep on the belt, the separator pulley revolving at about 50 r.p.m. and handling 5000 cu. ft. of charcoal in 24 hours.

The use of powdered or pulverized fuel has been

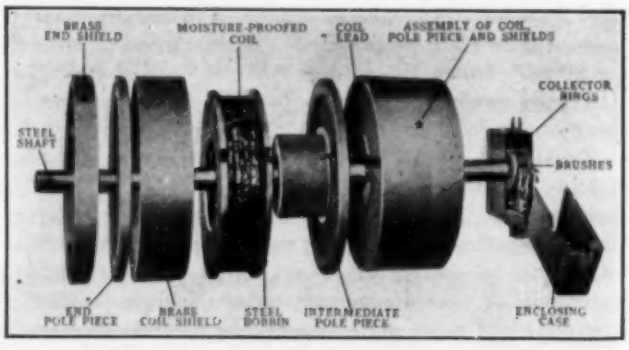


FIG. 1—EXPLODED VIEW OF C-H MAGNETIC SEPARATOR PULLEY.

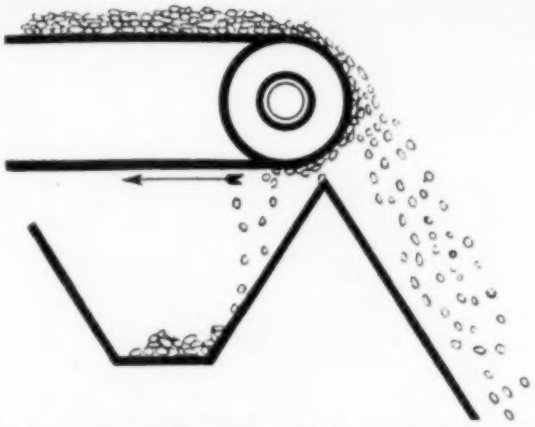


FIG. 2.—PRINCIPLE OF MAGNETIC SEPARATOR PULLEYS.

extended and this has led to the need of magnetic separators in cement plants, steel plants, powerhouses and many other kinds of plants. For open hearth furnaces, a brief mention is made here of the process of furnishing the pulverized coal and the use of the magnetic separator.

First the tramp iron is removed from the coal by means of magnetic separators. Coal as delivered to the milling plant always contains an astonishing amount of tramp iron in the form of bolts, nuts, rivets, nails, bar iron, railroad spikes, mule shoes, etc. Any of these materials entering the crusher or pulverizer might result in damage to the machine, with consequent delays in operation.

This foreign magnetic material can be entirely eliminated by the use of a magnetic separator located at some point ahead of the crusher. When the material passes over the above pulley which contains the magnet, the magnetic material, consisting of tramp iron, is attracted and held firmly against the belt and remains in contact with the belt until it leaves the magnetized zone, which is at some point beyond the under side of the magnetic pulley. The tramp iron drops from the belt after it leaves the pulley and is delivered to suitable boxes by means of a chute, the coal continuing on its course.

The shortage of natural gas caused the Missouri, Kansas & Texas Railroad to decide upon pulverized fuel for the water tube boilers in the powerhouse of the shops at Parsons, Kan. The equipment for pulverizing and drying fuel is contained in a separate building, which is located near one end of the boiler house, and the coal is dumped from the cars directly into a concrete track hopper adjoining this building. The plant is designed to handle either mine run or slack coal and immediately below the track hopper is placed a set of rolls, which reduce lumps up to 12 in. by 18 in. to 5-in. cubes or less in one operation. As the coal passes through this crusher it drops onto a belt conveyor, which discharges directly into a set of corrugated rolls. The upper end of the belt conveyor passes over a 24-in. by 22-in. Cutler-Hammer magnetic separator pulley, the function of which is to remove any pieces of iron or steel which may be in the coal and retain them on the belt until the latter passes off the underside of the pulley, the metal then dropping to the floor behind the crusher. This crusher reduces the coal to pass through a ¾-in. mesh or less and delivers it into a dust-tight elevator, from which it is distributed into a storage bin.

Furnishing powdered coal as a locomotive fuel by the Santa Fe made necessary a crushing plant and magnetic separator at Marceline, Mo. Here the coal (mine screenings) is fed through a drier, at the discharge end of which there is located a separator which takes out any tramp iron which may be in the coal.

The pulley is magnetized by passing direct current through the windings in the interior of the pulley.

Oxy-Acetylene Rivet Cutting

For cutting off rivet heads and stay-bolts flush with plates by the oxy-acetylene process, it is desirable to have a cutting tip so designed as to permit of the gas jet playing parallel with the plates.

To meet this need The Prest-O-Lite Company, Inc., of Indianapolis, Ind., is manufacturing a special rivet and stay-bolt cutting attachment. This attachment is

RIVET CUTTING ATTACHMENT.

used in connection with the Type K cutting blow-pipe shown, being screwed into the head in place of the regular cutting nozzles. The copper tip is bent at a convenient angle and is adjustable to any position, facilitating operation in close quarters.

Much cleaner work in rivet and stay-bolt cutting is possible with this attachment than with standard cutting tips which do not permit of a cut truly parallel with the plates.

Personal

Mr. **Francis B. Coyle**, metallurgist for the New Departure Manufacturing Company, Bristol, Conn., has resigned to assume new duties as metallurgical engineer for the Greenfield Tap & Die Corporation, Greenfield, Mass.

Mr. **J. R. Flannery** of Pittsburgh, Pa., president of the American Vanadian Company and the American Flexible Boat Company, has gone to Washington, D. C., to work with Henry P. Davison of J. P. Morgan & Co. on problems connected with the American Red Cross.

Messrs. **Ainslie Gray** and **Charles Benjamin** announce that they have formed a partnership, to be known as Gray & Benjamin, to act as advertising counsel to manufacturers of electrical, mechanical, chemical and kindred products. Their office will be in the Transportation Building, 608 South Dearborn Street, Chicago. Mr. Gray was formerly managing editor of *Electrical Review and Western Electrician*, and has been president of the Associated Business Papers, Inc. Mr. Benjamin was the first editor of *Printers' Ink*, and from 1906 to 1915 was advertising manager of the Cutler-Hammer Manufacturing Company of Milwaukee, Wis.

Frederic DeP. Hone & Co., engineers, announce the removal of their office to 13-21 Park Row, New York City.

Mr. **Philip N. Moore**, president of the American Institute of Mining Engineers, has completed visits to

several of the Western sections of the society and has returned to St. Louis.

Mr. **Louis Rasmussen** has resigned as superintendent of the Wisconsin Aluminum Foundry Company, Manitowoc, Wis., to take up other duties in Marshalltown, Iowa. He was tendered a banquet by the officers and employees of the company.

Dr. **A. W. Schorger,** who for seven years has been connected with the Forest Products Laboratory, Madison, Wis., has resigned to take charge of organic chemistry with the C. F. Burgess Laboratories at Madison, Wis. The Burgess Laboratories are actively engaged at present upon problems of national preparedness and defense, and are represented on both national and state committees. Dr. Schorger's immediate duties will be in connection with some of these problems, especially those relating to foodstuffs.

Mr. **H. N. Stronck** has been appointed vice-president and managing engineer of the Illinois Engineering, Auditing & Public Relations Company, 122 South Michigan Avenue, Chicago, this firm being successors to Benedict, Boyle & Stronck, Inc., and is engaged in general consulting business on engineering, construction, industrial economics, public relations, accounting and auditing.

Mr. **Maurice R. Thompson** of the Power and Mining Department, General Electric Company, Schenectady, N. Y., spent May and June at the new electrolytic zinc plant of the Judge Mining & Smelting Company at Park City, Utah. He will return to Schenectady via Butte, Great Falls and Trail, B. C.

Mr. **R. E. Vandruff,** president of the New Dominion Copper Company, was recently at Globe, Ariz., inspecting the properties of the company.

Mr. **John B. Wise,** superintendent of the electrolytic and acid plant of the Chile Exploration Company, Chuquicamata, Chile, will be in the United States on his vacation from June 15 to Sept. 15 of this year.

Book Review

The Mining Manual and Mining Year Book, 1917. By **Walter R. Skinner.** 960 pages. Price 15s., net. Post free; outside of England 17s., net. London: Walter R. Skinner.

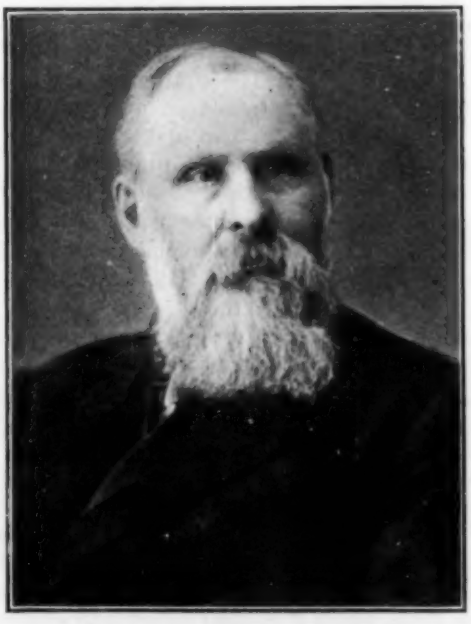
This is the thirty-first consecutive yearly issue of this valuable handbook of mining companies, engineers and directors. The work includes all mines whose shares are dealt in on the London Stock Exchange and many others, including many of the large American companies. The number of companies listed is 1710 and a supplementary list gives references to former volumes on 2286 additional companies. All the regular features of the work are included. In the preface a review is given of conditions throughout the world during the past year. The previous high standard of this book is maintained in this issue, and it should prove of great value to those who wish to be well informed on foreign mining.

Obituary

Alois von Isakovics, the well known proprietor of the Synfleur Scientific Laboratories, passed away at his home in Monticello, N. Y., on June 4. Mr. von Isakovics was born at Prague, Austria, in 1870, and came to this country when he was about sixteen years old. After he had been here several years he founded the Herbene Chemical Co., in Harlem. In 1895 he married Mary Upschur, whose home was in the Southern States. In 1904 he went to Monticello, N. Y., where he founded the Synfleur Scientific Laboratories. The business flourished and the company became very well known in the manufacture of perfumes, flavoring extracts, essential oils, and other chemicals. Mr. von Isakovics was a prominent member of the Perfumers' Association and was formerly active in the American Electrochemical Society. He delivered many lectures before the chemical and pharmaceutical classes in several of the large universities.

THE LATE ALOIS VON ISAKOVICS

Edward R. Taylor, the distinguished inventor of the continuous electric furnace process for the manufacture of carbon bisulphide and one of the pioneers of electrochemistry in this country, passed away at his home in Penn Yan, N. Y., on May 28. Mr. Taylor was born in



THE LATE EDWARD R. TAYLOR

St. Lawrence County, New York, in 1844, and was educated in England and America. He graduated from the Lawrence Scientific School of Harvard University in 1868. He was a professor of chemistry at the Homeopathic Hospital College in Cleveland from 1869-73, and chemist with the Cleveland Rolling Mill Company from 1869-76. He was president of the Taylor Chemical Company in Penn Yan for many years, relinquishing it a few years ago to his son, Dr. Charles Taylor. The manufacture of carbon bisulphide was commenced about 1899.

Mr. Taylor was a member of the American Electrochemical Society, American Chemical Society, American Institute of Chemical Engineers, Society of Chemical Industry and American Institute of Electrical Engineers.

CURRENT MARKET REPORTS

The Iron and Steel Market

The character of the steel market has changed entirely in the past few weeks, fully attaining the development that was referred to briefly in our last report. The business being done is of considerably smaller volume than even a fortnight ago, and is of much smaller volume than that of a few months ago. The character is altogether altered, as the buying is chiefly for what may be called early deliveries, in that they are earlier than most of the large mills can make as they are already filled with other business. The buying for distant deliveries, what came to be known last year as "delivery at mill convenience" has become inconsequential, and there are no market prices quotable. As a result, the only market that is quotable becomes the market for the earlier deliveries, in from three to six months, roughly speaking. Such prices are higher than would rule for the later deliveries, if there were such prices, and thus by a change in the nomenclature, or in the "argument" as the astronomer would put it, the market appears to have advanced more than it really has.

Prices currently quoted as representing the market are, for instance, 8c. to 9c. for blue annealed and black sheets, 4.25c. or 4.50c. for merchant bars and structural shapes, 8c. to 9c. for tank plate, and so on. These are the prices ruling on such business as is being done, but the business is largely of the emergency character. There is not represented, in the buying, any considerable amount of new construction, of car building, and the like. It is a market that cannot be maintained indefinitely unless an extremely large part of the steel output is diverted to war purposes, and of course at reasonable prices as provided by law for Government purchases. The rank and file of consumers cannot continue to do business if they must eventually pay the prices now quoted as the market.

The steel market, however, can get along for quite a while without a break, because the great bulk of the steel being shipped is invoiced at prices much below the current market. Striking an average of the various finished steel products, steel that was bought on the first of last October, and some undelivered steel was bought before that, was $50 a ton below the present market, while steel bought on Feb. 1, the date of the German submarine announcement, was about $36 below the present market.

The United States Steel Corporation has total tonnage obligations on its books, although variously distributed in the different departments, equal to its total output for about nine and a half months. The independents as a whole are booked to a somewhat smaller proportion of their capacity. As the Government places orders for steel, to be given precedence, and to the extent of 25 per cent, 40 per cent, or possibly even more of the output, the time in which the existing orders can be filled will be greatly lengthened.

Without doubt there is a slowing down in the consumption of steel. Building engagements have almost ceased. Even in May the fabricated steel contracts taken by the Bridge Builders' and Structural Society represented only 56½ per cent of the fabricating capacity. Railroad buying has practically ceased. Some of the automobile makers have materially curtailed their specifications for steel, with prospects of greater curtailment. Ford and a few others are, however, requiring more steel than they expected.

There is a great deal of newspaper talk about prices to be paid by the Government for steel, but the actual negotiations are very quietly conducted and the facts may never be fully known. The subject has been greatly confused by making comparisons of possible prices for the Government with prices now ruling on small lots for early delivery, paid by distressed buyers. It would be no strain whatever to the steel industry for the Government prices to be very much lower than the present quoted which are altogether fictitious as representing a real and broad market.

THE PIG IRON ADVANCE

At the time of last report the pig iron market was advancing wildly. It has since been advancing more conservatively, but still rather steadily, say at the rate of $1 to $2 per ton per week instead of $2 to $5. The $50 mark has been passed in some districts and not in others. The buying has been checked to a considerable extent as buyers realize the great risks incurred in purchasing for the first half of 1918, and there is little business left to be done for the remainder of this year.

The peculiar feature of the situation is that with pig iron at more than double the price it has reached in a third of a century there are some blast furnaces that are losing money, because they are still delivering pig iron sold last August and September at $18 and thereabouts, when costs have mounted very sharply, particularly because furnace coke must frequently be bought for spot shipment, to eke out the insufficient deliveries on contracts. Thus the blast furnaces have their future before them.

Non-Ferrous Metal Market

Monday, June 25.—There is practically no change in the copper market, pending Government developments. Tin has advanced during the last few weeks and lead remains strong. Spelter has been dull and antimony declined slightly. Silver has been strong and has advanced again.

Copper.—There is practically no change in the copper market and prompt electrolytic still rules around 32.50 cents with Lake at 31.00 to 31.50. A member of the Council of National Defense has stated that the Government ought not to pay more than 20 cents for copper but no definite action has been taken on the Government price as yet. It is understood that the Fed-

eral Trade Commission intends to make an investigation of the cost of producing copper.

Tin.—Straits tin has been scarce for prompt delivery and advanced from 60.75 on June 11 to 64.00 cents on June 19. It has since fallen off to 63.50. No special developments have been noted.

Spelter.—The spelter market has been characterized by its usual dulness and prices remain virtually unchanged. Prompt spelter has sold for 9.30 to 9.55 cents and these prices have remained steady during the last two weeks.

Lead.—The trust price of lead remains at 11.00 cents, New York, with the outside market asking 11.75 to 12.00 cents. The Government has purchased 8600 tons for which it is said to have paid 8 cents, St. Louis. The Government is expected to require 100,000 tons per year.

Other Metals.—Aluminium is unchanged at 59.00 to 61.00 cents for No. 1 Virgin. The Aluminium Company of America has offered to supply the Government at 27.50 cents per pound. Antimony has declined from 20.25 to 19.25 cents for spot. Magnesium can be had at 2.00 to 2.50 per pound. Quicksilver is $80 to $82. Platinum is $105, cobalt, $1.70 and silver 78½. Tungsten concentrates are $20.00-$22.00.

Chemical Market

Benzol.—Stocks of prompt benzol have generally been more than sufficient to answer the requirements of the trade but consumers have not been inclined to take hold to any great extent. Prices have held fairly well although they rule lower for the interval. Contracts are now available at attractive prices.

Toluol.—One cheap lot of resale material tended to lower values during the interval but aside from this fact prices have held rather well although the volume of business transacted has not been large. At the moment of writing the market has assumed a somewhat steadier aspect.

Phenol.—A production in excess of the demand continues and the market has eased off somewhat during the interval. The general situation is unsatisfactory from every viewpoint. A small export inquiry has developed but this has not materialized any important transactions.

Naphthaline.—This product has been offered more freely and balls in particular have been in abundant supply after a scarcity of some months. Flakes have also been offered more freely. The production continues on a large scale.

Beta Naphthol.—One manufacturer who discontinued the production of this product offered considerable quantities of surplus material at low prices during interval but these sales were not necessarily a reflection of general conditions. As a matter of fact the undertone is stronger due to the sharp advance in caustic soda.

Benzoic Acid.—A very large production of this material is noted at the present time and there are probably close to twenty firms producing the material either in glass or in a larger way. The season for large buying is now at hand but prices show but little evidence of this. Offers have been made and continue to be made on a very low basis, one, in fact that can allow but little encouragement to substantial producers. Some of the benzoic acid being produced leaves much to be desired. Practically the same conditions prevail in the *benzoate of soda market.* Production is large and prices have consequently dropped sharply.

Salicylates.—A pronounced scarcity is noted for salicylic acid and the *salicylates* and prices have advanced to high levels with supplies very difficult to secure. The tendency is still higher.

Monochlorbenzol.—A larger production has resulted in very free offerings with prices at a comparatively low level. There does not appear to be any immediate indication of an advance.

Dinitrophenol.—Spot supplies have been replenished and prices have receded with trading more restricted.

Caustic soda.—The market has climbed to even a higher level than when we last reported both for spot and contract and the speculative interest has been very active. Ground caustic continues very scarce and high. *Soda ash* has remained firm and active and owing to the fact that steamship companies have been refusing the product packed in ordinary barrels, hard wood casks have been in heavy demand for this style shipping.

Barium products.—There has been important inquiry for practically all barium compounds particularly *carbonate.* A production of *chlorate of barium* is being made here for the navy.

Copper sulphate.—Blue vitriol has been quiet with comparatively unimportant business. The export movement has not been large and has been principally to France and Spain as heretofore.

Cyanides.—With the exception of the potassium salt, all *cyanides* have been weaker and slow in movement. *Potassium,* however, is scarce and high.

Acids.—The situation generally is stronger. There have been no weak sellers. *Nitric* has been particularly strong although business has not been important. *Brimstone sulphuric acid* is revealing much firmness owing to the strong position of brimstone. *Muriatic acid* is also higher and rather more active.

General Chemicals

WHOLESALE PRICES IN NEW YORK MARKET, JUNE 22, 1917

Acetic anhydride	lb.	1.70	—	1.90
Acetone, drums	lb.	.27	—	.27½
Acid, acetic, 28 per cent	lb.	.05	—	.05½
Acetic, 56 per cent	lb.	.10	—	.11
Acetic, glacial, 99½ per cent, carboys	lb.	.35	—	.37
Boric, crystals	lb.	.13	—	.13½
Citric, crystals	lb.	.73½	—	.75
Hydrochloric, commercial, 18 deg	lb.	.01½	—	.01½
Hydrochloric, 20 deg	lb.	.01½	—	.01⅝
Hydrochloric, C. P., conc., 22 deg	lb.	.01¾	—	.01⅞
Hydrofluoric, 30 per cent, in barrels	lb.	.04¾	—	.05
Lactic, 44 per cent	lb.	.11	—	.12
Lactic, 22 per cent	lb.	.04½	—	.05
Nitric, 36 deg	lb.	.07	—	.07½
Nitric, 42 deg	lb.	.08	—	.08¼
Oxalic, crystals	lb.	.46	—	.47
Phosphoric, 85 per cent	lb.	.33	—	.37
Picric	lb.	.70	—	.75
Pyrogallic, resublimed	lb.	3.50	—	4.00
Sulphuric, 60 deg	ton	22.00	—	24.00
Sulphuric, 66 deg	ton	30.00	—	35.00
Sulphuric, oleum (Fuming), tank cars	ton	38.00	—	40.00
Tannic, U. S. P., bulk	lb.	.45	—	.50
Tartaric, crystals	lb.	.81	—	.82
Alcohol, grain, 188 proof	gal.	3.06	—	3.08
Alcohol, wood, 95 per cent	gal.	1.00	—	1.02
Alcohol, denatured, 180 proof	gal.	.72	—	.73
Alum, ammonia lump	lb.	.04¼	—	.04¾
Alum, chrome ammonium	lb.	.18	—	.19
Alum, chrome potassium	lb.	.30	—	.32
Alum, chrome sodium	lb.	.12	—	.12½
Alum, potash lump	lb.	.06½	—	.07
Aluminium sulphate, technical	lb.	.02	—	.02½
Aluminium sulphate, iron free	lb.	.03	—	.03½
Ammonia aqua, 26 deg. carboys	lb.	.07	—	.07½
Ammonium carbonate	lb.	.13	—	.14
Ammonium nitrate	lb.	.16	—	.17
Ammonium, sulphate domestic	100 lb.	6.25	—	6.35
Amyl acetate	gal.	4.50	—	4.60
Arsenic, white	lb.	.19	—	.20
Arsenic, red	lb.	.30	—	.60
Barium chloride	ton	80.00	—	90.00
Barium sulphate (Blanc Fixe, powder)	lb.	.04	—	.04½
Barium nitrate	lb.	.11	—	.11½
Barium peroxide, 80 per cent	lb.	.27	—	.27½

Bleaching powder, 35 per cent chlorine	lb.	.02	—	.02½
Borax, crystals, sacks	lb.	.07¾	—	.08
Brimstone, crude	ton	45.00	—	....
Bromine, technical	lb.	.80	—	.90
Calcium, acetate, crude	lb.	.03	—	.03½
Calcium, carbide	ton	80.00	—	90.00
Calcium chloride, 70-75 per cent, fused, lump	ton	26.00	—	28.00
Calcium peroxide	lb.	1.60	—	1.65
Calcium phosphate	lb.	.30	—	.31
Calcium sulphate	lb.	.10	—	.12
Carbon bisulphide	lb.	.04½	—	.04½
Carbon tetrachloride, drums	lb.	.16	—	.16½
Caustic potash, 88-92 per cent	lb.	.85	—	.86
Caustic soda, 76 per cent	100 lb.	6.75	—	6.85
Chlorine, liquid	lb.	.15	—	.18
Cobalt oxide	lb.	1.55	—	1.60
Copperas	100 lb.	1.00	—	1.05
Copper carbonate	lb.	.30	—	.32
Copper cyanide	lb.	.72	—	.74
Copper sulphate, 99 per cent, large crystals	lb.	.09½	—	.10
Cream of tartar, crystals	lb.	.48	—	.49
Epsom salt, bags	100 lb.	4.25	—	4.50
Formaldehyde, 40 per cent	lb.	.17	—	.18
Glauber's salt	100 lb.	.65	—	.70
Glycerine, bulk, C. P	lb.	.61	—	.62
Iodine, resublimed	lb.	3.50	—	....
Iron oxide	lb.	.02	—	.08
Lead, acetate, white crystals	lb.	.16	—	.17
Lead arsenate	lb.	.12¾	—	.13½
Lead nitrate	lb.	.17½	—	.18
Litharge, American	lb.	.08	—	.19
Lithium carbonate	lb.	1.02	—	1.05
Manganese dioxide, U. S. P	lb.	.55	—	.60
Magnesium carbonate, tech	lb.	.13½	—	.14
Nickel salt, single	lb.	.14	—	.14½
Nickel salt, double	lb.	.11	—	.12
Phosphorus, red	lb.	1.15	—	1.20
Phosphorus, yellow	lb.	1.90	—	2.00
Potassium bichromate	lb.	.35½	—	.36
Potassium bromide granular	lb.	1.00	—	1.05
Potassium carbonate calcined, 80-85 per cent	lb.	.70	—	.75
Potassium chlorate, crystals	lb.	.54	—	.55
Potassium cyanide, 98-99 per cent	lb.	2.20	—	2.25
Potassium iodide	lb.	2.90	—	2.92
Potassium muriate 80-85 p. c. basis of 80 p. c.	ton	360.00	—	365.00
Potassium nitrate	lb.	.31	—	.33
Potassium permanganate	lb.	4.00	—	4.10
Potassium prussiate, red	lb.	2.50	—	2.55
Potassium prussiate, yellow	lb.	.96	—	1.05
Potassium sulphate, 90-95 p. c. basis 90 p. c.	ton	350.00	—	375.00
Rochelle salts	lb.	.37½	—	.38½
Sal ammoniac, gray gran	lb.	.10	—	.11
Sal ammoniac, white gran	lb.	.15	—	.16
Sal soda	100 lb.	$ 1.20	—	1.25
Salt cake	100 lb.	.90	—	1.00
Silver cyanide	oz.	.70	—	....
Silver nitrate	oz.	.47½	—	....
Soda ash, 58 per cent, light, flat	100 lb.	2.75	—	2.85
Soda ash, 58 per cent, dense, flat	100 lb.	3.90	—	4.00
Sodium acetate	lb.	.09	—	.10
Sodium benzoate	lb.	4.75	—	5.50
Sodium bicarbonate, domestic	100 lb.	2.30	—	2.50
Sodium bicarbonate, English	lb.		—	....
Sodium bichromate	lb.	.15½	—	.16
Sodium bisulphite, powd	lb.	.03½	—	.04
Sodium chlorate	lb.	.24	—	.26
Sodium cyanide	lb.	.65	—	.70
Sodium fluoride, commercial	lb.	.13	—	.14
Sodium hyposulphite	lb.	.01¾	—	.02
Sodium nitrate, refined	lb.	.06	—	.06¼
Sodium nitrite	lb.	.49	—	.55
Sodium peroxide	lb.	.90	—	.95
Sodium phosphate (tri.)	lb.	.04¾	—	.05
Sodium prussiate, yellow	lb.	.29½	—	.30½
Sodium silicate, liquid —40 d g. Baumé	100 lb	1.50	—	1.60
Sodium sulphide, 30 per cent crystals	100 lb.	1.65	—	1.75
Sodium sulphide, 60 per cent, fused	100 lb.	2.90	—	3.25
Sodium sulphite	lb.	.03¼	—	.03½
Strontium nitrate	lb.	.28	—	.30
Sulphur chloride, drums	lb.	.06	—	.06½
Sulphur dioxide, liquid, in cylinders	lb.	.15	—	.20
Sulphur, flowers, sublimed	100 lb.	3.20	—	3.30
Sulphur, roll	100 lb.	2.55	—	2.60
Sulphur, crude	ton	45.00	—	46.00
Tin bichloride, 50 deg	lb.	.19¾	—	.20
Tin oxide	lb.	.64½	—	.65
Tungstic acid, basis 100 per cent	lb.	1.40	—	1.50
Zinc carbonate	lb.	.25	—	.27
Zinc chloride	lb.	.10¼	—	.11
Zinc cyanide	lb.	.50	—	....
Zinc dust, 350 mesh	lb.	.18	—	.20
Zinc oxide, American process XX	lb.	.15	—	.15½
Zinc sulphate	lb.	.06	—	.06½

Coal Tar Products (Crude)

Benzol, pure, water white	gal.	.55	—	.60
Benzol, 90 per cent	gal.	.57	—	.59
Toluol, pure, water white	gal.	1.80	—	1.90
Xylol, pure, water white	gal.	.50	—	.55
Solvent naphtha, water white	gal.	.19	—	.21
Solvent naphtha, crude, heavy	gal.	.13	—	.16
Creosote oil, 25 per cent	gal.	.31	—	.33
Dip oil, 20 per cent	gal.	.29	—	.30
Pitch, various grades	ton	8.00	—	20.00
Carbolic acid, crude, 95-97 per cent	lb.	1.05	—	1.10
Carbolic acid, crude, 50 per cent	lb.	.55	—	.60
Carbolic acid, crude, 25 per cent	lb.	.32	—	.35
Cresol, U. S. P	lb.	.25	—	....

Intermediates, Etc.

Alpha naphthylamine	lb.	.90	—	1.05
Aniline oil	lb.	.29	—	.31
Aniline salts	lb.	.34	—	.35
Anthracene, 80 per cent	lb.	.10	—	....
Benzaldehyde	lb.	4.50	—	5.00
Benzidine, base	lb.	1.85	—	2.00
Benzidine, sulphate	lb.	1.55	—	1.60
Benzoic acid	lb.	5.00	—	5.50
Benzyl chloride	lb.	2.00	—	2.10
Beta naphthol benzoate	lb.	11.00	—	12.00
Beta naphthol, sublimed	lb.	.70	—	.75
Beta naphthylamine ecm	lb.	2.50	—	....
Dichlor benzol	lb.	.22	—	.23
Dinitrochlorbenzol	lb.	.46	—	.48
Dimethylaniline	lb.	.55	—	.60
Diphenylamine	lb.	.95	—	1.00
H-acid	lb.	3.25	—	3.50
Metaphenylenediamine	lb.	1.70	—	1.75
Monochlorbenzol	lb.	.26	—	.28
Naphthalene, flake	lb.	.09½	—	.10
Naphthionic acid, crude	lb.	1.50	—	1.75
Nitro naphthaline	lb.	.45	—	.50
Nitro toluol	lb.	.50	—	.55
Ortho-amidophenol	lb.		—	....
Ortho-toluidine	lb.	1.00	—	1.15
Para-amidophenol, base	lb.	5.00	—	6.00
Paranitraniline	lb.	1.10	—	1.15
Paraphenylenediamine	lb.	3.75	—	4.00
Para toluidine	lb.	1.90	—	2.00
Phenol, U. S. P	lb.	.40	—	.42
Resorcin, technical	lb.	8.50	—	9.00
Resorcin, pure	lb.	16.00	—	17.00
Salicylic acid	lb.	1.35	—	1.45
Salol	lb.	1.85	—	2.00
Sulphanilic acid	lb.	.32	—	.33
Tolidin	lb.	3.00	—	....
Toluidine-mixture	lb.	.75	—	.85

Petroleum Oils

Crude (at the Wells)

Pennsylvania	bbl.	3.10	—	....
Corning, Ohio	bbl.	2.40	—	....
Somerset, Ky	bbl.	2.20	—	....
Wooster, Ohio	bbl.	2.18	—	....
Indiana	bbl.	1.78	—	....
Illinois	bbl.	1.92	—	....
Oklahoma and Kansas	bbl.	1.70	—	....
Caddo, La., light	bbl.	1.90	—	....
Corsicana, Tex., light	bbl.	1.70	—	....
California	bbl.	.88	—	1.22
Gulf Coast	bbl.	1.00	—	....

Lubricants

Black, reduced, 29 gravity, 25-30 cold test	gal.	.13½	—	.14
Cylinder, light	gal.	.21	—	.26
Cylinder, dark	gal.	.18	—	.19
Paraffine, high viscosity	gal.	.29½	—	.30
Paraffine, .903 sp. gr	gal.	.21½	—	.22
Paraffine, .865 sp. gr	gal.	.18½	—	.19

Flotation Oils

(Prices at New York)

Pine oil, steam distilled, sp. gr. 0.925-0.940	gal.	.52	—	....
Pine oil, destructively distilled, sp. gr. 0.920-0.940	gal.	.48	—	....
Pine-tar oil, sp. gr. 1.025-1.035	gal.	.25½	—	....
Pine-tar oil, double refined, sp. gr. 0.965-0.990	gal.	.35	—	....
Pine oil, light, sp. gr. 0.950, tank cars, f.o.b. works	gal.	.37	—	....
Pine oil, heavy, sp. gr. 1.025, tank cars, f.o.b. works	gal.	.26	—	....
Pine tar, thin, sp. gr. 1.060-1.080	gal.	.22	—	....
Turpentine, crude, sp. gr. 0.980-1.000	gal.	.40	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 0.960-0.990	gal.	.19	—	....
Hardwood oil, f.o.b. Michigan, sp. gr. 1.06-1.08	gal.	.19	—	....

Vegetable and Other Oils

China wood oil	lb.	.16½	—	.16¾
Cottonseed oil, crude	gal.	1.11	—	....
Linseed oil, raw, cars	gal.	1.17	—	....
Peanut oil, crude	gal.	1.15	—	....
Rosin oil, first run	gal.	.38	—	....
Rosin oil, fourth run	gal.	.67	—	....
Soya bean oil, Manchuria	lb.	.14½	—	....
Turpentine, spirits	gal.	.43	—	....

Miscellaneous Materials

Barytes, floated, white, foreign	ton	38.00	—	40.00
Barytes, floated, white, domestic	ton	28.00	—	32.00
Beeswax, white, pure	lb.	.60	—	.65
Carnauba wax, flor	lb.	.53	—	....
Casein	lb.	.19	—	.28
Chalk, light, precipitated, English	lb.	.03	—	.06
Feldspar	ton	8.00	—	12.00
Fuller's earth, powdered	100 lb.	1.00	—	1.50
Ozokerite, crude, brown	lb.	.60	—	.70
Ozokerite, American	lb.	.35	—	....
Red lead, dry, carloads	lb.	.13	—	....
Rosin, 280 lb	bbl.	6.15	—	....
Soapstone	ton	10.00	—	12.50
Talc, American, white	ton	10.00	—	13.00
White lead, dry	lb.	.11½	—	....

Refractories, Etc.

(F.O.B. Works)

Chrome brick	net ton	Nominal		
Chrome cement, Grecian	net ton	60.00	—	....
Clay brick 1st quality fireclay	per 1000	45.00	—	....
Clay brick, second quality	per 1000	30.00	—	....
Magnesite, raw	ton	30.00	—	35.00
Magnesite, calcined	ton	40.00	—	55.00
Magnesite, Grecian, dead burned	net ton	90.00	—	....
Magnesia brick, Grecian, 9x4½x2½	net ton	140.00	—	....
Silica brick	per 1000	45.00	—	....

Ferroalloys

Ferrocarbontitanium, 15-18 per cent, car loads, f.o.b. Niagara Falls, N. Y	ton	160.00	—	....
Ferrochromium	lb.	Nominal		
Ferromanganese, domestic, delivered	ton	425.00	—	450.00
Ferromanganese, English	ton	200.00	—	....
Ferromolybdenum, per lb. of Mo	lb.	4.25	—	....
Ferrosilicon, 50 per cent, carloads, del., Pittsburgh	ton	240.00	—	250.00
Ferrosilicon, 50 per cent, contract	ton	100.00	—	....
Ferrotungsten, 75-85 per cent, f.o.b. Pittsburgh	lb.	2.00	—	....
Ferrovanadium, f.o.b. works	lb.	3.25	—	3.50

INDUSTRIAL

Financial, Construction and Manufacturers' News

Financial

New Companies

The Alaska-Pacific Construction Company of Portland, Ore., has been incorporated with a capital of $300,000 for the purpose of constructing and operating steam, gas and sailing vessels. The incorporators are Charles A. Burckhardt, John H. Burgard and Lawrence A. McNary.

American Oil Developing and Leasing Corporation of Wilmington, Del., has been incorporated with a capital of $500,000.

American Oil Products Company of Wilmington, Del., has been incorporated with a capital of $500,000 to acquire lands and develop same.

The American Reduction & Chemical Company of Bellair, Ohio, has been incorporated with a capital of $50,000. The incorporators are J. A. Greenfield, A. C. Beetham, James W. Stewart, C. M. Wyrick and C. H. Dankworth.

Atlas Graphite Corporation of Birmingham, Ala., has been incorporated with a capital of $125,000. The incorporators are L. H. Weller, president; C. E. Massey, vice-president; John M. Hughes, secretary-treasurer.

Aurora Foundry Company, Seattle, Wash., has been incorporated with a capital of $10,000. The incorporators are John H. Ironside and Charles Budd.

A. W. Zinc & Lead Corporation has been incorporated in Delaware with a capital of $1,000,000 to conduct a general mining business. The incorporators are Harry McDaniel, Jr., L. B. Phillips, J. B. Bailey, Dover, Del.

The Beaver Chemical Company, Inc., of New York City, N. Y., has been incorporated with a capital of $10,000 to manufacture chemicals, drugs, etc. The incorporators are H. and B. Lichtenberg, S. Fillin, 2013 Bryant Avenue, Bronx, N. Y.

Calumet Iron & Metal Company of Chicago, Ill., has been incorporated with a capital of $25,000. The incorporators are Samuel Goldberg, Henry Goldberg, Benjamin Friedman.

Cherokee Oil & Gas Company of Augusta, Me., has been incorporated with a capital of $1,000,000 to quarry, mine, melt, refine, prepare for market, etc., any metals, mineral substances, oil and gas.

Commonwealth Lead & Zinc Company has been incorporated in Delaware with a capital of $600,000 to acquire mining property and develop same. The incorporators are Arthur W. Britton, Louis H. Gunther, Harry B. Davis, New York City.

Connecticut Steel Corporation of Bridgeport, Conn., has been incorporated with a capital of $20,000 to carry on business of every kind of manufacturing of metal and metal articles. The incorporators are William S. Lane and Arnold W. Knauth of New York, and Cornelius C. Webster of Brooklyn, N. Y.

The Constatin Refining Company of Delaware has been incorporated with a capital of $5,000,000 to refine, store and market crude oil and by-products thereof. The incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del.; Clement M. Egner, Elkton, Md.

C. T. Products Corporation of New York City, N. Y., has been incorporated with a capital of $25,000 to manufacture chemicals and pharmaceutical preparations. The incorporators are J. A. Haggerty, C. C. Cooper, F. C. Peters, 120 Broadway.

Cuprite Sulphur Corporation of Delaware has been incorporated with a capital of $2,000,000 to carry on a general mining business, including that of gold, silver, sulphur, etc. The incorporators are Paul A. Zrezelman and William C. Griffith of New York, and Ernest H. Greenwood of Montclair, N. J.

Diament Oil & Gas Corporation of Buffalo, N. Y., has been incorporated with a capital of $75,000 to manufacture and deal in natural gas and petroleum products. The incorporators are R. E. Diament, J. H. Clark, M. E. Butler, all of Buffalo.

Dickerson Glue Joint Company of Grand Rapids, Mich., has been incorporated with a capital of $30,000. The incorporators are D. F. Hamilton, Glenn Dickerson and William English.

The Economy Fuel Company of Portland, Ore., has been incorporated with a capital of $20,000 to deal in real and personal property in Portland. The incorporators are Elizabeth Tipton, R. J. Streicher and Robert H. Down.

Frederick Iron & Steel Company, Frederick, Md., has been incorporated with a capital of $150,000 to manufacture, purchase, sell and otherwise deal in iron, steel, brass, copper and metals, etc. The incorporators are William A. Riddel, George M. Gittinger and Claude S. Hahn, all of Frederick.

Gilmore Manufacturing Company of New York City, N. Y., has been incorporated with a capital of $10,000 to manufacture shoe black, ink dyes, chemicals, drugs. The incorporators are Benjamin Lifshitz, Robert Scherer, Morris Lippman.

Hightower Peanut Oil Mill of Brundidge, Ala., has been incorporated with a capital of $35,000 to manufacture peanut oil.

Inspiration Zinc & Lead Company of Wilmington, Del., has been incorporated with a capital of $250,000. The incorporators are M. L. Gatchell, L. A. Irwin, Harry W. Davis, of Wilmington.

Kansas-Utah Consolidated Oil Company of Wilmington, Del., has been incorporated with a capital of $3,000,000.

Kentucky Oil & Refining Co. of Wilmington, Del., has been incorporated with a capital of $1,000,000 to acquire oil lands and develop same.

Kinney-Brennan Petroleum Company has been incorporated in Delaware with a capital of $1,000,000 to produce and market petroleum, natural gas, coal and minerals. The incorporators are F. R. Hansell, Philadelphia, Pa.; J. V. Pimm and S. C. Seymour, Camden, N. J.

Lawrence Oil Corporation, New York, N. Y., has been incorporated with a capital of $2,000,000 to acquire oil lands and to develop the same. The incorporators are Arthur W. Britton, Louis H. Gunther, Harry B. Davis, all of New York.

The Linde Air Products Company has been authorized to manufacture oxygen, nitrogen and other gases in Oregon, with a capital of $200,000.

Linden Chemical Company of Linden, N. J., has been incorporated with a capital of $125,000 to manufacture and deal in chemicals. The incorporators are Adam J. Traub, Elizabeth; Norman W. Kempf and Louis A. Kempf, Newark.

Majestic Paint Company of St. Louis, Mo., has been incorporated with a capital of $10,000 to manufacture and deal in paints, oils, etc. The incorporators are S. B. Cowan, E. A. Koeneman and E. C. Breck, George L. Zollman and Chester Chapline.

Marine Steel Company of Wilmington, Del., has been incorporated with a capital of $250,000. The incorporators are M. L. Rogers, L. A. Irwin, Harry W. Davis of Wilmington.

The Metallograph Corp. of New York City, N. Y., has been incorporated with a capital of $540,000 to manufacture and refine brass, copper and other metals. The incorporators are I. M. Berliner, F. Spungin, J. J. Cohen, 135 West 115th St., New York.

Michigan Drop Forge Company of Delaware has been incorporated with a capital of $1,800,000 to manufacture iron and steel products. The incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del.; Clement M. Egner, Elkton, Md.

Milliff Refining Company, of Martinez, Cal., has been incorporated with a capital of $100,000 to operate a refinery.

National Aniline and Chemical Co., Inc., West Nyack, N. Y., has been incorporated with a capital of $17,231,000 to manufacture chemicals, coal tar products. The incorporators are I. F. Stone, W. Beckers, W. N. McIlravy, 17 Battery Place, New York.

Nitro-Phospho Corporation of Richmond, Va., has been incorporated with a capital of $500,000. The incorporators are M. C. Patterson, pres., T. S. Winston, v.-pres., John Landstreet, secretary-treas.

Ohio Mold and Foundry Company of Cincinnati, Ohio, has been incorporated with a capital of $50,000. Mr. C. B. Matthews, incorporator.

The Old Spanish Copper Co. has been incorporated in Delaware with a capital of $1,000,000 to produce oil and gas and acquire land containing the same. The incorporators are G. A. Lemmon, W. C. Darlington, H. Kolb, J. F. Ringle, J. H. Derieux, all of Strang, Okla.; L. Sier, Omaha, Nebr.

The Pacific Potato Starch Company has been organized with a capital stock of $60,000, to manufacture potato starch and by-products. Incorporators of the company are J. F. Griffith, Albert Muesig, and J. A. Turner. A plant will be erected.

Palladium Paint Company of Atlanta, Ga., has been incorporated with a capital of $25,000. The incorporators are N. T. Poole, A. W. Stirling, and F. A. Quillian.

J. F. Patton & Co. of Delaware has been incorporated with a capital of $100,000 to buy and sell pulp, paper, etc. Representative J. F. Patton, 83 West 42nd St.

Republic Graphite Company of Jasper, Ala., has been incorporated with a capital of $100,000. The incorporators are John H. Bankhead, Jr., H. E. McCormack, W. A. Clark and others.

Residuum Oil and Burner Company has been incorporated in Delaware with a capital of $1,000,000 to manufacture and sell devices to facilitate combustion of oils, fuels and particularly residuum oils. The incorporators are Herbert E. Latter, Henry M. Robinson, Wilmington, Del., Clement M. Egner, Elkton, Md.

Sapo Chemical Co. of Toledo, Ohio, has been incorporated with a capital of $50,000.

Shynoff Chemical Co., Inc., of New York City, N. Y., has been incorporated with a capital of $6,000 for chemical business. The incorporators are P. Glass, S. Sussman, M. I. Price, 271 Broadway, N. Y.

Southern Ferro Alloys Co. of Knoxville, Tenn., has been incorporated with a capital of $210,000 to manufacture ferro alloys. The incorporators are J. Harry Price, W. F. Black, Geo. C. Hager and others.

Steel Works Appliance Company of Pittsburgh, Pa., has been incorporated with a capital of $5,000. The incorporators are August Gums, Stephen Buchle, Pittsburgh; J. A. Whitehouse, Carrick, Pa.

The Tool Steel Corporation of Pittsburgh, Pa., has been incorporated with a capital of $600,000. The incorporators are Robert McKnight, F. M. Neeper, A. M. Neeper, Pittsburgh, Pa.

White-Burbank Paper Co., Inc., of New York City, N. Y., has been incorporated with a capital of $50,000 to manufacture paper and wood pulp. The incorporators are L. O. White, 146 Central Park West; C. I. Hamilton, 145 West 138th St., New York City; F. W. Burbank, 1916 Albemarle Road, Brooklyn.

Wonder Paper and Fabric Company, Wilmington, Del., has been incorporated with a capital of $2,100,000. The incorporators are Herbert E. Latter, Henry M. Robinson, Clement M. Enger, Wilmington, Del.

Zobel, Stern & Campbell, Inc., New York City, N. Y., has been incorporated with a capital of $20,000 to manufacture colors and dyestuffs. The incorporators are H. E. Zobel, G. M. Campbell, B. F. Meyer, 253 Ninth St., Brooklyn, N. Y.

Capital Increases

Western Utah Copper Company of Nevada has increased its capital from $50,000 to $2,500,000. The officers are Harold R. Smoot, president, and Edwin T. Jones, secretary.

The American Gas & Incinerator Company of Vancouver, Wash., has filed amended articles of incorporation, increasing its capital stock from $30,000 to $40,000. C. R. Talbot, vice-president.

The National Electrolytic Company, Canal Basin, Niagara Falls, N. Y., manufacturer of chemicals, has increased its capital from $620,000 to $1,150,000.

Construction and Operation

Alabama

BESSEMER.—The American Tar Product Company expects to build an addition to its plant at Woodward for the manufacture of naphthaline for the making of explosives. The plant is at present turning

out creosote and other coal tar products. The new by-product ovens of the Woodward Company will furnish the product for running the naphthaline plant.

Arkansas

CAMDEN.—The Camden Foundry Company has built a new and large fireproof building of concrete and iron to replace the building recently destroyed by fire.

FORT SMITH.—S. P. Hardin and associates of Clarksburg, W. Va., and Pittsburgh, Pa., will erect a glass making plant which will cost $250,000 and employ 250 men. Two cars of window and plate glass will be manufactured per day. They expect the capacity to be doubled in a year.

TEXARKANA. — The Commercial Acid Company has just completed its new plant to replace the one burned a few months ago. The new fireproof building is of brick, concrete and galvanized iron. This building is equipped with new machinery.

Colorado

DENVER.—The Denver Steel & Iron Works will operate the largest structural steel plant in the intermountain region. It was formerly the Lowith Brothers Iron Works Company, located at West Colfax Avenue and Larimer Street, and was purchased by the Monarch Engineering Works. It will be run under the above name. They expect to produce enough structural steel to supply the entire Western territory.

Delaware

WILMINGTON.—The New Castle Leather Company will build six new additions to its plant at Eleventh and Poplar Streets. Erection of two of the structures has been commenced.

WILMINGTON.—The Otto Gas Engine Company of Philadelphia has sold its land in South Wilmington to a syndicate of Philadelphia and New Jersey capitalists. A steel plant will be erected on this property. The property includes several hundred acres along the south side of the Christiana River.

Georgia

MARIETTA.—The Glover Machine Works will have shortly, in connection with their plant, a steel foundry and forge shop. They will install an electric furnace, steam hammers, sand blast machinery, grinders, sand mixing machinery, etc. The Glover Machine Works specializes on industrial locomotives.

Idaho

LEADORE.—The Sunset Mining Company, which has recently developed enormous deposits of ore at its properties, located at Leadore, Idaho, will construct a new mill in the near future. Shipments of ore running 15 to 20 per cent lead and 8 to 12 ounces per ton continue to come in regularly. Much development work is being done and it has now been definitely determined that the 500,000 tons of milling ore which has been blocked out can be mined and put into the mill at the rate of 60 cents per ton.

Illinois

NORTH CHICAGO.—The Sexton Oil Company has opened its new factory at North Chicago, which will have an output of 300,000 gal. of oil a week without double shifts. The company makes a patented motor oil.

Indiana

TERRE HAUTE.—The Grasselli Chemical plant is expected to be in operation July 1. The plant will make spelter exclusively for the manufacture of brass and galvanizing and is claimed to be the largest of its kind in the world.

Kansas

NEODESHA. — Improvements to the amount of $300,000 will be made in the plant of the Standard Oil Company of Kansas this summer to increase the capacity for the manufacture of gasoline. Twenty stills will be added, making a total of 112, which will make it one of the largest plants in the Middle West.

Maryland

BALTIMORE.—The Baltimore Tube Company will erect a new plant, 140 by 600 ft., for the manufacture of sheet brass and copper, which will cost between $500,000 and $600,000.

BALTIMORE. — The Penn-Mary Steel Company will build a new one-story concrete copper shop, about 60 x 120 ft.

Michigan

DETROIT.—Henry Ford intends to proceed with the erection of a large blast furnace plant just outside of Detroit.

Missouri

ST. LOUIS.—The Majestic Paint Company, recently organized with a capital of $10,000 has made extensive alterations on its building at 1103 Locust Street and 403 North Eleventh Street. The company is agent for the Ohio Paint & Varnish Company of Cleveland, Ohio.

Montana

BUTTE.—The Continental Oil Company plans the construction of a plant covering a block in Valley Addition. Work will be completed during the summer.

HAVRE.—Local men who are boosting the flax fiber mill expect to have the plant in operation in the near future. A building, 50 x 50 ft., will be built. Company has been incorporated under the name of The Flax Mills Company, by F. F. Bossout, James Holland, E. C. Sweitzer, W. C. McKelvey, E. C. Carruth and C. F. Morris, with capital stock of $100,000.

New Jersey

NEWARK. — The Harrison Chemical Company has purchased waterfront property; also several buildings which are to be remodeled for its needs. This property comprises six acres at Newark Transfer, with a 300-ft. frontage on the main channel of the Passaic River, extending back 900 ft. to the tracks of the Jersey Central Railroad. This property was held at $75,000 and adjoins the plants of the Sun Oil Company and the Butterworth-Judson Company.

NEWARK.—The Alcohol Products Company will spend $75,000 on a new manufacturing plant which is to be located at the foot of Blanchard Street. It will be composed of a refinery building of brick and reinforced concrete construction, with a boiler room, and an office and laboratory building.

New York

JAMAICA BAY, LONG ISLAND.—The Corrugated Fiber Mills, Inc., purchased 5 acres together with buildings, having 70,000 sq. ft. of space, at the head of Mill Basin, Jamaica Bay, for the manufacture of paper products.

JOHNSON CITY.—Endicott, Johnson & Company have ordered the material for a new fiber board mill. This building will be started about Aug. 1, and it is expected that it will be completed in the late fall. The building will be 370 ft. in length, 250 ft. of which will be one-story and the remaining 120 ft. two stories and basement. The new plant will manufacture fiber board.

LAUREL HILL.—The General Chemical Company filed plans recently with the Building Bureau in Long Island City for a steel laboratory, 48 by 33 ft., to be erected at Washington and Laurel Hill Avenues, Laurel Hill, adjoining the company's present buildings. The laboratory will cost $6,000.

WARREN.—The Warren Oil Company intends to buy 12 acres of land on which to construct a blending plant. Improvements approximating $50,000 will be placed upon the new property.

Ohio

YOUNGSTOWN.—The Youngstown Sheet & Tube Company will erect a new steel plant for the manufacture of 84-in. plates at a cost of $2,000,000.

Oklahoma

ENID.—A contract was signed between the Southwestern Oil Corporation and the Enid Refining Company for the construction of a pipeline from the oil fields east of Enid to Enid, and the building of another refinery.

Oregon

ASTORIA.—The Standard Oil Company here has purchased a block of land on the waterfront and will expend $150,000 in construction of a thoroughly fireproof plant. F. E. Roper, of Seattle, will direct installation of the plant.

MOLLALA.—The Mollala Fire Clay Company has started work on its clay mine near Mollala. A 100 ft. tunnel is being driven, and work on the kilns will begin shortly. The company holds the only clay deposit known on the Pacific coast which will make white stoneware pottery.

Pennsylvania

CARNEGIE.—The Superior Steel Company has purchased extensive property adjoining its works, for the erection of new additions.

CORNWALL.—The Bethlehem Steel Company is reported to be planning to double the capacity of its local iron ore properties, providing a total of 80,000 tons per month.

HARRISBURG.—The Keystone Industrial Corporation, recently incorporated with capital of $1,500,000 to manufacture boilers, engines, etc., is reported to be planning for the erection of its proposed plant at Middletown. George W. McIlhenny, 25 North Thirteenth Street, and D. A. Caley, 23 North Fourth Street, are the principal incorporators of the company.

PHILADELPHIA.—The Kali Manufacturing Company is enlarging its equipment in the plant at 1406 North Front Street by installing larger motors and new machinery. The company expects to increase its manufacture of oils for the textile trade.

PHILADELPHIA.—The Gill Glass Company acquired title to two tracts in the northeast section of Philadelphia on which it will erect a large factory building.

PHILADELPHIA.—The India Refining Company, manufacturer of oils, has filed plans for alterations and improvements in its plant at Swanson and McKeon Streets to cost $2,500.

PHILADELPHIA.—The Powers-Weightman-Rosengarten Company, Ridge Avenue and Calumet Street, is planning for the erection of a one and two-story brick addition to cost about $25,000 to replace the section of its plant recently destroyed by fire.

PHILADELPHIA.—The Nice Ball Bearing Company has awarded a contract for the erection of a one and three-story addition to its plant about 170 x 320 ft., at Twenty-ninth Street and Hunting Park Avenue, to cost $175,000. William Steele & Sons Company, contractors.

PHILADELPHIA.—Fire, June 2, destroyed part of the plant of the Barrett Manufacturing Company, Tucker and Bermuda Streets, with loss estimated at $40,000.

PHILADELPHIA. — The Philadelphia Paper Company is arranging for the immediate erection of its proposed new one-story plant, about 170 x 270 ft., at Manayunk.

PHILADELPHIA. — The Pierce-Arrow Tire & Rubber Manufacturing Company, Germantown, is having plans prepared for the erection of a new plant to cost about $150,000. J. Osborn Hunt, Trenton, N. J., is architect.

PHILADELPHIA. — The Westmoreland Chemical & Color Company has filed plans for the erection of an addition to its plant on Twenty-second Street.

PHILADELPHIA.—The American Pulley Company, 4200 Wisahickon Avenue, manufacturer of pulleys, hangers, etc., will build a one-story addition, about 50 x 70 ft.

READING.—The Reading Knob Works, Oakbrook, will build a new one-story foundry addition, about 50 x 50 ft.

WARREN.—The Warren Oil Company purchased 12 acres of land lying west of Warren upon which will be built a blending plant. Improvements approximating $50,000 will be placed on the property.

Tennessee

MOUNT PLEASANT.—The Hoover & Mason Phosphate Company is building a new plant about one and a half miles from Mount Pleasant on the Mount Pleasant Southern Railroad. It will cover five acres of a 650-acre tract which contains phosphate enough to engage employment for twenty-five years. It is being built entirely of steel construction.

NASHVILLE.—The Nashville Products Co. is a new manufacturing concern located at 912 Church Street, to manufacture floor cleaners and disinfectants. The promoters are I. W. King and Henry Foster of Nashville.

Utah

SALT LAKE CITY.—The Utah Paraffine Oil & Wax Co. will erect an oil shale distillation plant for the manufacture of crude oil, paraffine wax and ammonium sulphate. The company has been experimenting for three years and will use a distillation process similar to those used on oil shales in Scotland. Mr. Lawrence Greene of Salt Lake City is president and general manager of the company and Mr. O. W. Ewing is managing director. Research work has been conducted at the University of Utah and Detroit Testing Laboratories.

Virginia

NEWPORT NEWS.—The Empire Steel Company, recently incorporated, is planning for the purchase of a local site for the installation of a large steel works. The plant is estimated to cost about $900,000, and will include steel furnaces, billet mill and auxiliary structures. The local Chamber of Commerce (J. N. Shannahan, president), is interested in the project. Joel F. Armistead, Atlanta, Ga., is head of the company.

Washington

CHEWELAH.—The Northwest Magnesite Company has completed plans for proposed development of its magnesite claims. A large crushing mill will be installed immediately, an aerial tramway built, and six rotary kilns installed, with capacity of 600 to 1000 tons daily. A big plant, costing $200,000, will be started as plans are completed. R. S. Talbot heads the concern.

IRONDALE.—After an idleness of almost five years, the blast furnace of the defunct Western Steel Corporation at Irondale, Wash., about 50 miles from Seattle, is being placed in working condition by the Pacific Coast Steel Company of Seattle, who has acquired the property. Between $75,000 and $100,000 will be expended before the furnace is ready to blow in, and the work will require sixty days' time. Engines and machinery of the plant, which has been damaged by long idleness, will be overhauled, and new equipment added at many points. Practically the entire inclosing structure will be replaced by new buildings, the big wharf will be rebuilt, and the ore and coke elevators overhauled. Present plant has capacity of 60 tons daily, which will not be increased at present. William Piggott, president of the Steel Company.

NORTHPORT.—The Northport Smelting & Refining Company is building and equipping a plant for the treatment of smelter gas, to cost in the neighborhood of $100,000. Structure will be 75 x 150 ft., and equipped with a series of 900 pipes, to which metallic particles will be attracted electrically while suspended in the fumes. The equipment is known as the Cottrell system, and is expected to save 5 per cent of the values, and pay for itself in six months of use.

SEATTLE.—The Linde Air Products Company, a New York concern, has leased a site at Eighth Avenue South, Seattle, on which a big plant will be erected. The main building will be one-story, 130 x 382 ft., of reinforced concrete and steel, costing $300,000.

SEATTLE.—The General Basic Products Company, located at 2926 Sixteenth Avenue S. W., although organized but two years, has a modern manufacturing plant, and has developed a splendid business, both local and foreign. The plant manufactures stone cement, stucco, fireproofing materials, sanitary wall finishes, calcimine, cold water paints and Puritan Lime. The company does a large export business.

SEATTLE.—The Puget Sound Cement & Lime Company, Seattle, according to V. C. Coxhead, has leased thirty-five acres of State land near Ballard, on which it plans to build a plant for the manufacture of cement and plaster and lime.

SEATTLE.—A series of experiments by the College of Mines, University of Washington, indicates that graphite from the Seward peninsula of Alaska can be refined for commercial use, according to Joseph Daniels, Assistant Professor of Mining. Samples of graphite have been refined by the concentration process.

SEATTLE.—The American Nitrogen Products Company, Securities Building, will start work at once on additions to its nitrogen plant at La Grande, which will make the plant three times its present size. The first unit, now in operation, cost $50,000.

SPOKANE.—Oliver P. Moore, secretary-treasurer of the Washington Steel & Iron Company, has invented and patented a new oil and gas burning smelter furnace. It is a combination consisting of a pre-heating and reduction chamber and a smelting and refining chamber.

SPOKANE.—Day Brothers, owners of the Hercules Mine, are making large additions to the Wallace Mill, including installation of four tube mills, 36 Franz tables and additional jigs. The improvements are to permit of remilling the tailings for the iron, to be used at the Northport smelter.

SPOKANE.—Washington State Pharmaceutical Association will convene in Spokane on June 14, 15, 16. A. W. Linton is secretary of the association.

SPOKANE.—The Spokane-Benton County Natural Gas Company has applied to the city council for a franchise to pipe natural gas into the city, build a distribution plant which will produce 2,000,000 cu. ft. of gas daily.

SPOKANE.—The Spokane Corrugated Culvert & Tank Company, of this city, plans to immediately double the size of its factory, and extend its lines of manufacture. C. A. Mowry is secretary-treasurer and general manager. Approximately $20,000 worth of new machinery will be installed, and an addition, 100 x 100 ft., together with an office building, will be constructed.

TACOMA.—E. D. Gallaher, general manager of the American Minerals Producing Company of Tacoma, is at the head of a syndicate which proposes to develop an extensive deposit of potassium nitrate and sodium nitrate near Vale, Ore. An experimental plant will be installed at the property, which is claimed by chemists to contain nitrate of high value and tremendous quantity.

TACOMA.—Frank S. Baker, local, who is at the head of a project to install a paper mill near Tacoma, states that details for the plant are complete, and construction will begin shortly. Plant, including buildings and machinery, will cost $400,000.

West Virginia

CLARKSBURG.—The Hope Natural Gas Company will erect a gas producer plant at Downs for experimental purposes. The capacity of the plant when completed will be equal to two ordinary gas wells. The product will be used to operate the big gas producing stations and what is not used will be turned into the gas mains to experiment with the natural product. The coal to run the producer will be supplied by the Rachel Coal Company.

KANAWHA CITY.—The Libbey-Owens Sheet Glass Company and the Owens Bottle Machine Company will be in operation shortly, making an investment of $5,000,000 and will be the largest sheet glass and bottle plants in the world. These plants cover a site of 76 acres, and will employ hundreds of men. C. W. McNulty & Company of Charleston and Huntington have the contract for the general construction work at the Libbey-Owens Sheet Glass plant, while the Toledo firm of Devore-McGormley Company, industrial engineers and architects, planned the several buildings which constitute the great plant. W. J. Monaghan of Toledo, is the supervisor of the construction for the architects. The main building is to be 504 ft. in length and 396 ft. in width. In the front portion of the building six tanks have been constructed, each 72 ft. long, 20 ft. wide and 5 ft. deep and each having a capacity of 470 tons where the molten glass is made. Mr. William Jacobs of Toledo will be the manager of the plant and Arthur E. Fowle general manager.

Wisconsin

MILWAUKEE.—The Wisconsin Metal Refining Company, Fratney and Franklin Streets are occupying their new factory which is 80 by 150 ft.

ST. FRANCIS.—The Valley Forge Company of Pittsburgh, is to build a $1,000,000 steel mill at St. Francis, in Milwaukee County. The mill will be about 100 x 300 ft. of light steel frame and wood sheathing.

Wyoming

COWLEY.—The Columbia Carbon Company of New York will erect a large plant for the manufacture of carbon black at Cowley, Wyo. The carbon black will be manufactured from natural gas drawn from the wells of the Wyoming Consolidated Oil Company. The first building of the unit will be 14 ft. by 114 ft. The first unit will have 96 buildings of this dimension, which will cost $600,000.

Manufacturers' Notes

CATALOGUES AND TRADE PAPERS WANTED IN CHILE.—Commercial Attaché William F. Montavon, at Lima, Peru, recently visited the library and reading room of the Sociedad de Fomento Fabril in Santiago, Chile, an organization with headquarters in Santiago, which has for its purpose the promotion of manufacturing in Chile. The Secretary of the Sociedad de Fomento Fabril is desirous of exchanging the bulletin of its association with trade and industrial journals in the United States. The Secretary would also appreciate receiving catalogues of American manufacturers and exporters, which will be placed on file in the library and reading room. The address of the society is: "Sociedad de Fomento Fabril, Casilla 44-D, Santiago, Chile."

THE ROSS POWER EQUIPMENT CO. have been appointed Indianapolis representatives for The Lincoln Electric Company of Cleveland, Ohio, and their offices are at 617 Merchants Bank Bldg., Indianapolis, Ind.

RESOURCES OF BOLIVIA ON EXHIBITION.—The Consul General of Bolivia, in the United States, announces that he has now on exhibition, at the Consulate—forty-first floor of the Woolworth Building, New York City—a part of the minerals, rubber, precious woods and other native products of the Republic of Bolivia, that were shown at the late Panama-Pacific Exposition in San Francisco. He would be pleased to receive callers to view the specimens. This exhibit will be maintained at the Consulate as a permanent feature to aid in the dissemination of information regarding opportunities in Bolivia. All inquiries should be addressed to the Secretary.

LARGE HEATING AND VENTILATING INSTALLATION. — The National Acme Company of Cleveland, Ohio, has placed an order with the Buffalo Forge Company, Buffalo, N. Y., for a large heating and ventilating equipment. The equipment consists of four Carrier type "A" air washers with automatic control and fresh and return air dampers; four Niagara Conoidal supply fans, two of which deliver 100,000 cu. ft. of air per minute each, and two 95,000 cu. ft. of air per minute each; four exhaust fans, two of which will handle 70,000 cu. ft. of air each and two 50,000 cu. ft. of air per minute each; ten Baby Conoidal fans for toilets; twenty-seven thousand sq. ft. of Vento and four 12 x 14 steam engines for driving the fans. Geo. S. Rider & Co. are the consulting engineers.

PRODUCTION OF COPPER IN 1916.—An advanced official statement of the production of copper in the United States in 1916 has been issued by the Geological Survey. The author is B. S. Butler. The smelter production of primary copper was 1,928,000,000 pounds, compared with 1,388,000,000 pounds in 1915, an increase of 39 per cent. Arizona was the largest producer again with a record of 694,847,307 pounds. Montana was second with 352,139,768 pounds, and Michigan third with 269,794,531 pounds. Utah, Alaska, New Mexico and California follow in the order named. The total production of new refined copper in 1916 was 2,259,000,000 pounds, an increase of 625,000,000 pounds over 1915. The production of secondary copper was 104,423,807 pounds. In addition to the secondary material treated by the regular refining companies, plants that treated secondary material exclusively, produced a total of about 558,000,000 pounds of copper as copper and in brass and other alloys of copper, making a total production of 662,000,000 pounds from secondary sources. Of this total at least 250,000,000 pounds was produced by remelting clean scrap produced in the manufacture of copper and brass articles.

There was also produced about 56,000,000 pounds of bluestone, averaging 23-25 per cent copper.

THE MANUFACTURE OF PHTHALIC ACID AND PHTHALIC ANHYDRIDE.—The Department of Agriculture announces that the Color Investigation Laboratory of the Bureau of Chemistry, of this Department, has perfected, on a laboratory scale, a new process for the manufacture of phthalic acid and phthalic anhydride. This process, as carried out in the laboratories, appears so promising that it is thought that some manufacturers of chemicals and dyestuffs in this country may be able to supply their demands for these compounds by this process, provided the process can be reproduced upon a technical scale so as to obtain results commensurate with the laboratory investigations.

With a view to helping the chemical industry of this country, the Department of Agriculture hereby announces that it is ready to assist manufacturers who wish to produce these compounds. The expenses of the technical installation and of the labor and materials necessary will of necessity be borne by the firm, individual or corporation wishing to manufacture the products. The chemists of the Color Investigation Laboratory will assist with expert advice, etc. The Department reserves the right to publish all the data obtained from the technical experiments.

Since it seems very desirable that phthalic acid and phthalic anhydride be made available in large quantity in this country at the earliest possible moment, this offer of assistance will not be held open by the Department for an indefinite period.